GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

COAL CRUSHERS · 73
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PUMP MAINTENANCE · 126

Power

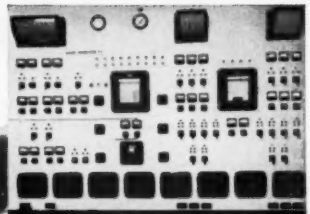
July
1951 · 50¢

A McGRAW-HILL PUBLICATION

combined with Operating ENGINEER

Big boiler buildup on West Coast — p 3

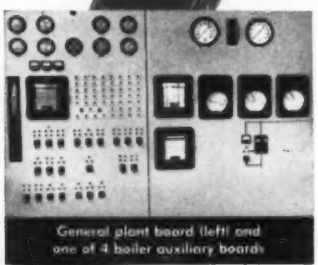
Central Control for Sunbury Engineered and Built by L&N



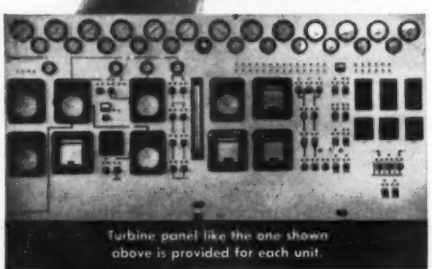
One of 4 Metermax combustion control panels for Sunbury

One of 2 generator panels

Desuperheater control board



General plant board (left) and one of 4 boiler auxiliary boards



Turbine panel like the one shown above is provided for each unit.

The new Sunbury station of Pennsylvania Power & Light Co. strikingly demonstrates the value of centralizing boiler and turbine control for maximum convenience and minimum operating personnel. L&N specialists translated PP&L control requirements into a finished design. Involved are 20 panels, totalling 157 front feet, with over 900 instruments, switches, controllers, signals and accessories located in convenient operating sequence for coordinated control of four boilers and two turbines.

12,000 Man-Hours of Panel Engineering

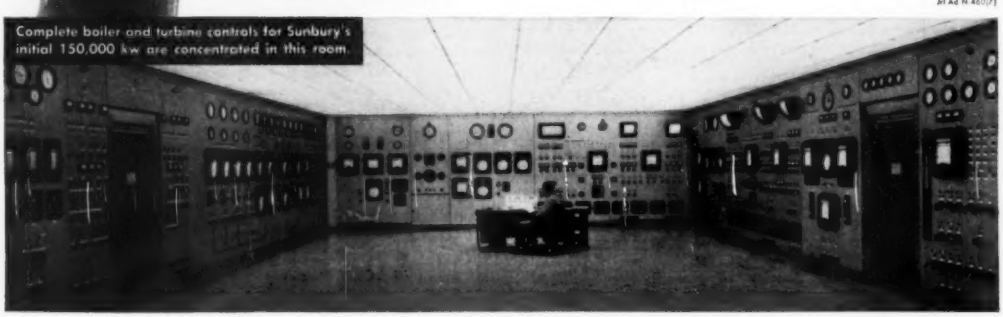
Over 12,000 man-hours of L&N engineering time were required. Panels were assembled in the L&N shop and shipped to the site fully wired, piped and tested. Similar L&N-designed control is being provided for the third and fourth units at Sunbury.

If you're planning a new station or adding to capacity, L&N control room design can save many man-hours of your engineering and on-the-site construction time. We'll be glad to send you our folder showing detailed panel layouts of central control rooms which we have recently supplied.

Write to our nearest office, or to Leeds & Northrup Company, 4910 Stenton Avenue, Philadelphia 44, Pa.

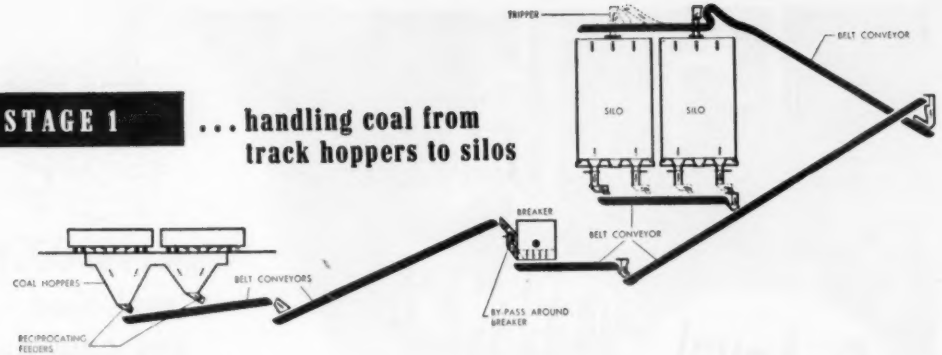
LEEDS NORTHRUP

M Ad N 460(7)

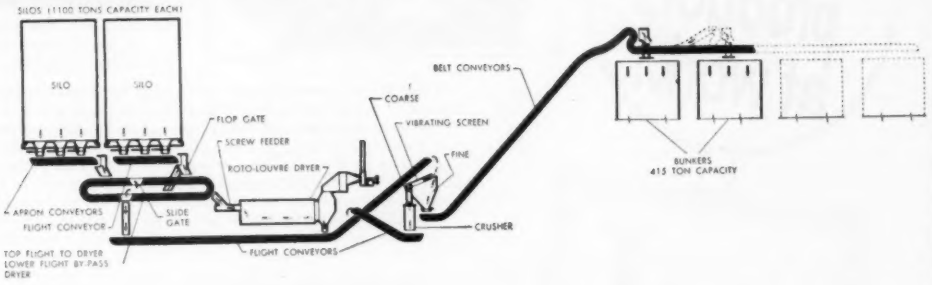


Complete boiler and turbine controls for Sunbury's initial 150,000 kw are concentrated in this room.

STAGE 1 . . . handling coal from track hoppers to silos



STAGE 2 . . . handling coal from silos through dryer to bunkers



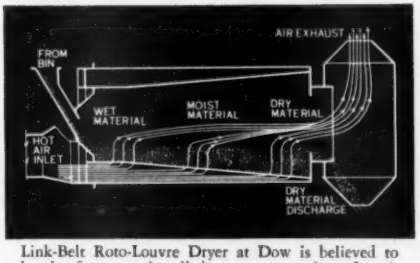
New power plant dries its own coal!

Dow's South Station utilizes wet, low grade bituminous with LINK-BELT equipment

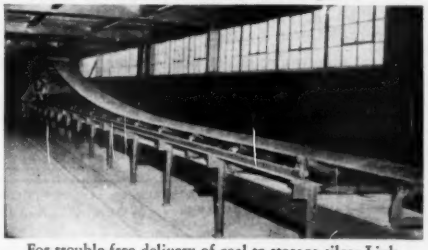
Economical steam generation of power moved a step forward when Dow's new power plant at Midland, Mich., went into operation. By installing a Link-Belt Roto-Louvre Dryer, Dow makes a low grade bituminous easier to handle . . . a better fuel.

And the 14 conveyors and feeders are all Link-Belt—apron, belt, flight and reciprocating types.

You, too, can put Link-Belt's vast coal handling experience to work for you. From our complete line, our engineering staff will help you or your consultants plan for highest efficiency in coal handling.



Link-Belt Roto-Louvre Dryer at Dow is believed to be the first ever installed at a power plant. Longitudinal section shows flow of material and gases.



For trouble-free delivery of coal to storage silos: Link-Belt tank type Tripper and Belt Conveyor with Type "100" Idlers.

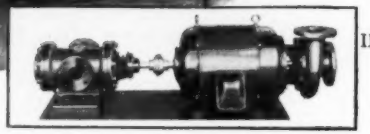
LINK-BELT

COAL HANDLING EQUIPMENT

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 12,478

De Laval products at work!

Keeping 192,000 H.P. well oiled and cooled...



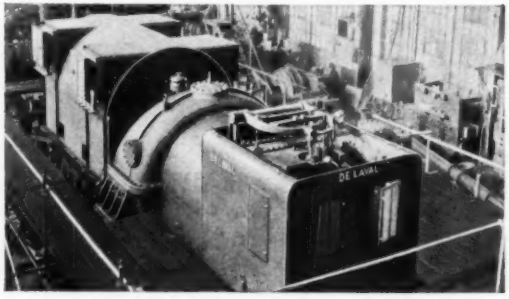
120 of these De Laval combined IMO rotary and centrifugal pump sets handle all the lube oil and jacket cooling water for 120-1600 hp radial gas engines in one of America's largest aluminum ore reduction plants.

The IMO is a versatile rotary pump that has dozens of applications around a power plant. You'll find them in high and low pressure fuel oil burner sets, pumping fuel oil to burners, unloading and transferring fuel and diesel oil, handling oil for lighting off and stand by service, providing pressure lubrication on pumps and turbines . . . We could fill the page with different applications but would rather send you a copy of our *Bulletin LG*. It shows the complete line of IMO's for capacities to 1000 gpm at pressures to 500 psi and 150 gpm at pressures to 1500 psi. *Write for your copy today.*

Meet the Grandaddy of all Turbines...

The first turbine-driven generating set to produce current on a commercial scale in the United States was this De Laval unit installed at the Chicago World's Fair in 1893. Grandad was a fast man in his day too . . . he delivered 10 hp at 24,000 rpm. Just four years later, four De Laval 100 hp turbine generators operating at 2840 psi, 750° F and two 50 hp turbines operating at 1420 psi supplied all the power for the Stockholm Exhibition. That is high pressure, high temperature operation even by todays' standards!

Next time you're in our neighborhood stop in and see Grandad. He is on display in our reception room. Then let us take you through our shops . . . there you'll see how the finest turbines in the country are built.



On Test – 11,500 KW

This big De Laval turbine generator and another just like it will soon go into service supplying power for one of our key Naval Bases. De Laval Turbine-Generators, *(we build them from 25 to 11,500 KW)* are at work in industrial, central station and municipal power plants all over the country. *Ask for a copy of our new Bulletin 4200.* Let it convince you that you should call in a De Laval engineer on your next turbine-generator job.

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

50th DE LAVAL Anniversary

Power

JULY 1951 VOLUME 95 NO. 7

combined with Operating ENGINEER

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(Member ABC and ABP)

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POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own index annually, copies of which are available on request to the editorial offices.

BOILERS are big business on the West Coast these days. Long a hydro stronghold, California now turns to steam power as booming demand outstrips water-power potential.

Our cover catches this trend in an impressive shot of a B & W radiant boiler at Pacific Gas & Electric's Moss Landing Station. Wielding the ratchet hoist is a member of the C C Moore Co erection crew.

Boiler is one of six 475,000-lb-per-hr units supplying three 100,000-kw turbine-generators. One of these machines has been operating about a year, other two see service soon. With two more turbine-generators and their boilers planned for 1952, this 1300-psi 950-F outdoor plant promises to be the largest west of the Mississippi. But these days who can tell?

Next month . . .

■ Right in the heat of the baseball season we're pulling a triple play of our own. In August you'll find the lowdown on wells and well pumps in—count em! —three places: basic facts in the E&M section, care and repair in PO&M, tips on testing in the Data Sheet. Be sure you cover all bases!

■ At Sewaren they've gone all out to get maximum makeup purity. You'll see why in August's story on how they treat city water for evaporator feed.

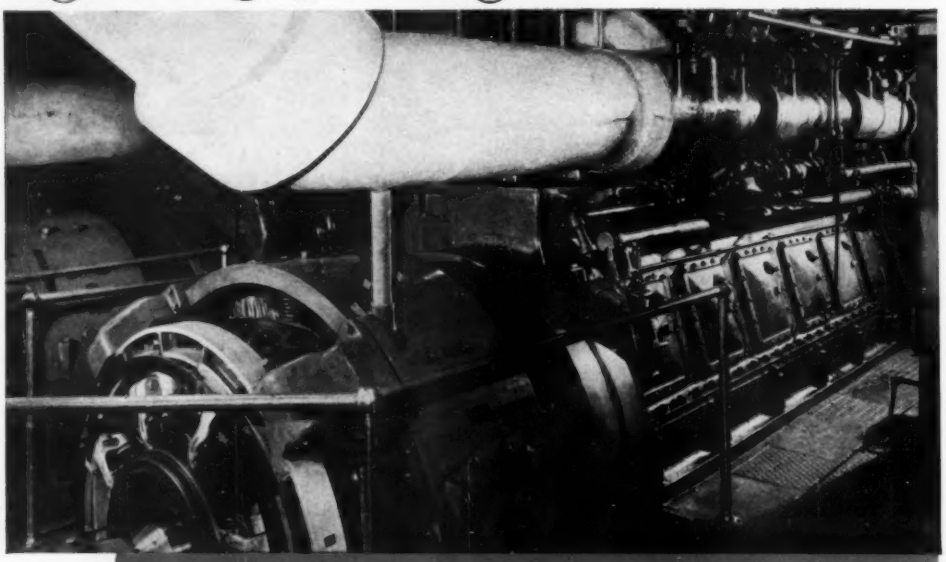
■ Another *Man of Action* story takes you to Eastman Kodak's Hawkeye plant, tells you how Wayne Farrell keeps on top of his job of making this plant tops in efficiency, cleanliness.

■ Got some electrical equipment to hang on a wall? Grab Jim O'Connor's "baby" special section on anchors—that's where you'll find all the new wrinkles—and tested old ones—for doing the job quickly and easily.

. . . and future months

■ Being readied for October: a 16-pg handbook on fans (both draft and ventilating). It'll cover basic fan facts, types and arrangements, construction, fan characteristics, drives and control, selecting and applying fans, operating and maintaining them.

Sing a song of savings



Lubricate with TEXACO URSA OILS

Your engines—Diesel, gas or dual-fuel—will really hum when you lubricate with *Texaco Ursa Oils*. And *you'll* sing their praises when you see how these famous oils resist oxidation . . . assure clean engines, free rings, open ports and properly functioning valves . . . real harmony.

Texaco Ursa Oils thus assure better compression and combustion, smoother operation, minimum wear. Bearings and all moving parts last longer . . . maintenance costs and fuel consumption go down. Change your tune . . . switch to *Texaco Ursa Oils* for stepped-up efficiency and economy.

Texaco Diesel lubricating oils are available in every needed viscosity, and there is a complete line of them approved by leading engine builders. They are No. 1 in popularity from coast to coast! For example, in the Diesel field:

> More stationary Diesel h.p. and more railroad Diesel locomotives in the U.S. are lubricated with Texaco than with any other brand.

Let a Texaco Lubrication Engineer direct you to greater savings throughout your plant. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

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...with Power readers...

FLAW THAT MARS . . .

There is one thing wrong with your new and enlarged POWER, *a flaw that mars the perfect gem.*

Some of the pages do not display, anywhere on either side of the sheet, the name POWER. *For those who dismember the magazine for filing articles by subject, this is a serious omission. To be sure, on such pages one finds "Engineering and Management Section", but this might not always be a sufficient identification of the source.*

My best wishes for the continued success of what is obviously a magnificent evidence of skillful direction.

Cambridge, Mass. C HAROLD BERRY

The new "footline" is designed to identify the sections of the magazine while avoiding a "cluttered" look. The name POWER *should* appear on one side of each sheet, unless something goes wrong. If such one-side identification isn't enough, let us know and we'll change it.—*Ed.*

. . . AND EATING IT TOO.

I think it goes without saying you really have a fine magazine and now with the merging of OE and POWER *we are having our cake and eating it too.*

The many worthwhile articles of interest are varied to the extent to be satisfactory and worthwhile to everyone from the coal

(*Continued on page* 212)

...lines and bylines

"DUCK SOUP" said POWER staffers when we decided early last Fall to do over the POWER Handbook. "Judging by reader letters and demand for reprints, the original was a bang-up job. All we need to do is bring it up to date, make it easier to read and look at."

Bill Arrott, assistant editor assigned to shepherding the job, agreed. But neither he nor the rest of the gang reckoned with the itch for perfection found in acute form in dyed-in-the-wool engineering editors.

Arrott at the start . . .

THE ITCH began to show up when individual editors drew up outlines for their technical specialties. Each of 'em had about three times as much good stuff lined up as space allowed. And each had ideas for improving what had been done before.

We're used to this — POWER pieces always start lots longer than they wind up. Its editors have learned how to squeeze out surplus words, put complex ideas into simple sketches—to trim off fat and leave the meat busy readers want.

. . . at the quarter post

FRANTIC, but orderly, struggle began to put all these skills to work at peak effectiveness. Careful page layouts organized presentation for maximum content, easiest reading. Drawings and sketches were made, reviewed, remade. New tables, crammed full of useful facts, were compiled, then reproduced in our Varitype department using new, highly condensed but legible type faces. And text was written, pruned, rewritten, pruned again, to get most ideas in fewest words.

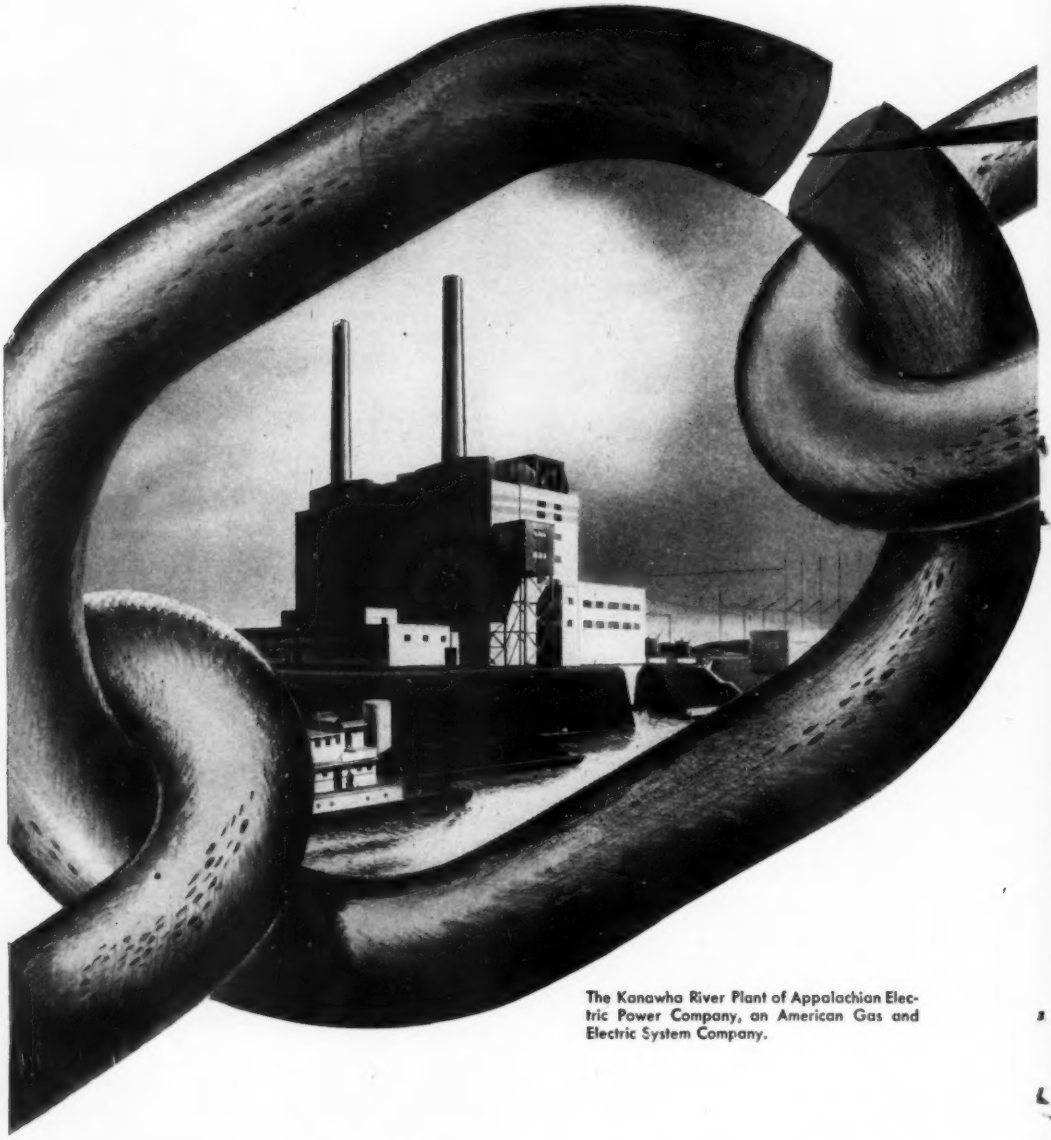
. . . in the homestretch

"IT WAS A HARD FIGHT, MOM, but we won!" At least that's how we feel now. We think we've hit a new peak for number of useful ideas and facts per square inch of page. And, we hope, we've kept it easy to read and easy to look at.

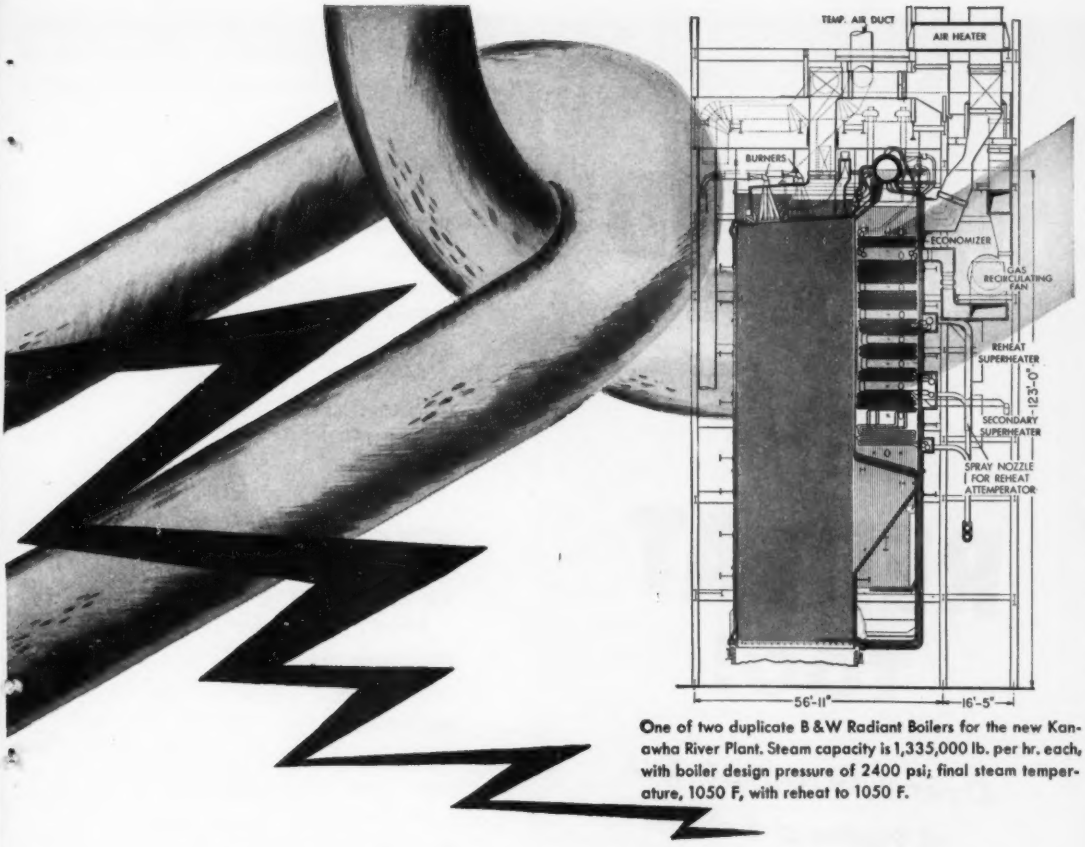
Except that it came in a concentrated dose, putting together the Handbook was much the same as the job we tackle each month. And, as for any issue, you're the judge of how well we succeed. Let's hear from you!

. . . the winnah!

KANAWHA



The Kanawha River Plant of Appalachian Electric Power Company, an American Gas and Electric System Company.



One of two duplicate B&W Radiant Boilers for the new Kanawha River Plant. Steam capacity is 1,335,000 lb. per hr. each, with boiler design pressure of 2400 psi; final steam temperature, 1050 F, with reheat to 1050 F.

Forging the Future of AMERICA'S POWER

A monument to faith in America's future power is rising in the Kanawha Valley—where the Kanawha River generating plant of Appalachian Electric Power Company will ultimately link a million new kilowatts to the massive forge of U.S. production for defense and peace.

Part of a quarter-billion dollar expansion budget, Kanawha will start up with the world's two largest single-boiler generating units—2,670,000 lb. per hr. combined total steam capacity, serving a round-the-clock gross generating capability of 434,520 kw . . . almost double the present demand of all industrial and residential customers in the area it will serve.

Kanawha's boilers are *big*. Their furnaces, of the divided-type, will have the highest heat-input of any boilers ever built—1,860,000,000 BTU per boiler, per hour . . . and the two boilers will burn over a million tons of coal yearly. Boiler design incorporates two of the latest B&W-pioneered features: pressurized furnaces and gas-recirculation . . . the latter combined with spray attemperation in the superheater to give steam-temperature control over a wide range of capacity.

With their large reheat capacity, high temperature-pressure characteristics, and the additional efficiencies inherent in pressure-furnace operation and recirculation of flue-gases, these units will contribute much to the expected plant heat-rate of 9,035 BTU per net kw-hr. . . . probably the lowest ever attained.

Kanawha is a striking testimonial to the fact that 67 years of phenomenal improvement in power generation have not dulled the industry's keen sense of progress. Courage and far-sightedness of our power companies, and their confidence in supplier organizations, will surely continue to forge new links in the chain of technological development that has made this industry, and the millions it serves, a continuing power in America's greatness and strength.

BABCOCK & WILCOX

G-5401

DIAMOND *Leads* WITH REHEAT TOO!

Over 8,000,000 kw* of Postwar Reheat Boiler Capacity Has DIAMOND SOOT BLOWERS Already Installed or On Order (see list)

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Philip Sporn

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Twin Branch

INDIANA MICHIGAN ELECTRIC CO.
Tanners Creek

NIAGARA MOHAWK POWER CORP.
Oswego

DAYTON POWER & LIGHT CO.
Hutchings (Units 1 and 2)

NEW ENGLAND POWER CO.
Salem

PENNSYLVANIA POWER CO.
New Castle

DUKE POWER CO.
Lee

PUBLIC SERVICE CO. OF NORTHERN ILL.
Waukegan

NEW YORK STATE GAS & ELEC. CO.
Goudey

PUBLIC SERVICE ELEC. & GAS CO.
Sewaren

UNION ELECTRIC CO.
Meramec (Unit 1)

CENTRAL HUDSON GAS & ELEC. CO.
Danskammer

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited—Windsor, Ontario

CONSUMERS POWER CO.
Erie

JERSEY CENTRAL POWER & LIGHT CO.
So. Amboy

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Wood River

AMERICAN GAS & ELECTRIC CO.
Kanawha

AMERICAN GAS & ELECTRIC CO.
Muskigum

DAYTON POWER & LIGHT CO.
Hutchings (Units 3 and 4)

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Ridgeland

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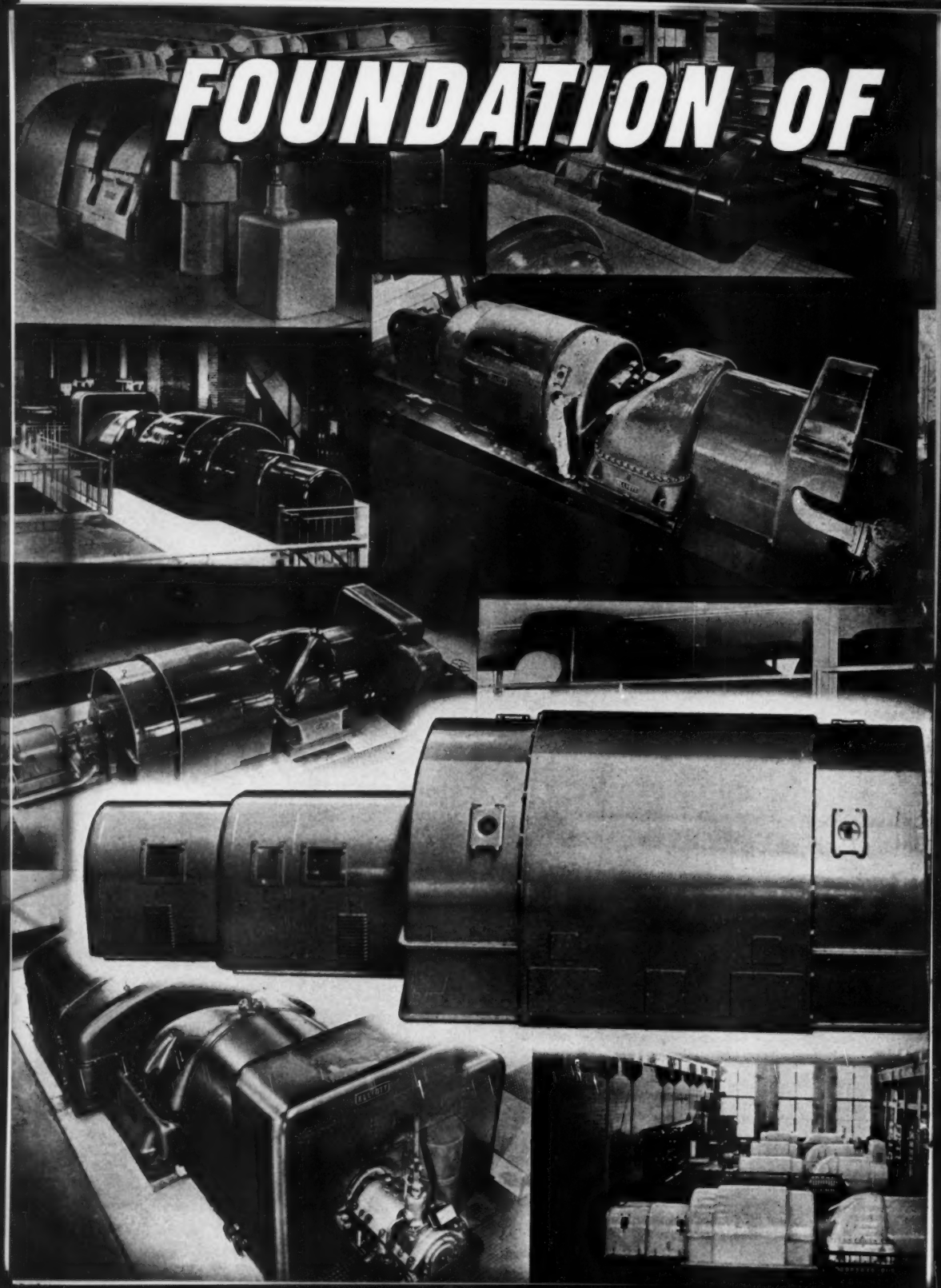
JERSEY CENTRAL POWER & LIGHT CO.

KANSAS CITY POWER & LIGHT CO.
Hawthorn

DIAMOND ECONOMY MATCHES REHEAT ECONOMY

*Based on list included in paper "The Trend Toward Reheat" presented at Midwest Power Conference, April, 1951. List above incomplete—soot blowers for some reheat boilers still pending.


FOUNDATION OF

RELIABLE POWER...
ELLIOTT
TURBINE-GENERATORS
■ Many fine stations—small to relatively large—are building a reputation for reliable, notably low-cost power generation on the solid basis of turbine-generators and related equipment engineered by Elliott... Some of these units are shown here, ranging in capacity from 5,000 to 15,000 kw.... Both driving and driven elements are designed, built, assembled and tested in Elliott shops, assuring the inestimable advantage of an integrally unified machine, and single responsibility for overall performance.
HALF CENTURY OF POWER PROGRESS
1901 1951
ELLIOTT COMPANY
STEAM TURBINE DEPT. P, JEANNETTE, PA.
Plants at: JEANNETTE, PA.
RIDGWAY, PA. • AMPERE, N. J.
SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES
ELLIOTT

How to the Efficiency Boiler-Room

Before you get steam you've got to spend dollars—so dollars are a form of energy.

And if your boiler-room dollars are invested in equipment that isn't working efficiently, economically, your "investment" is poor.

That's where co-ordinated controls by Bailey can help. Here's why they'll increase your "boiler-room investment efficiency":

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

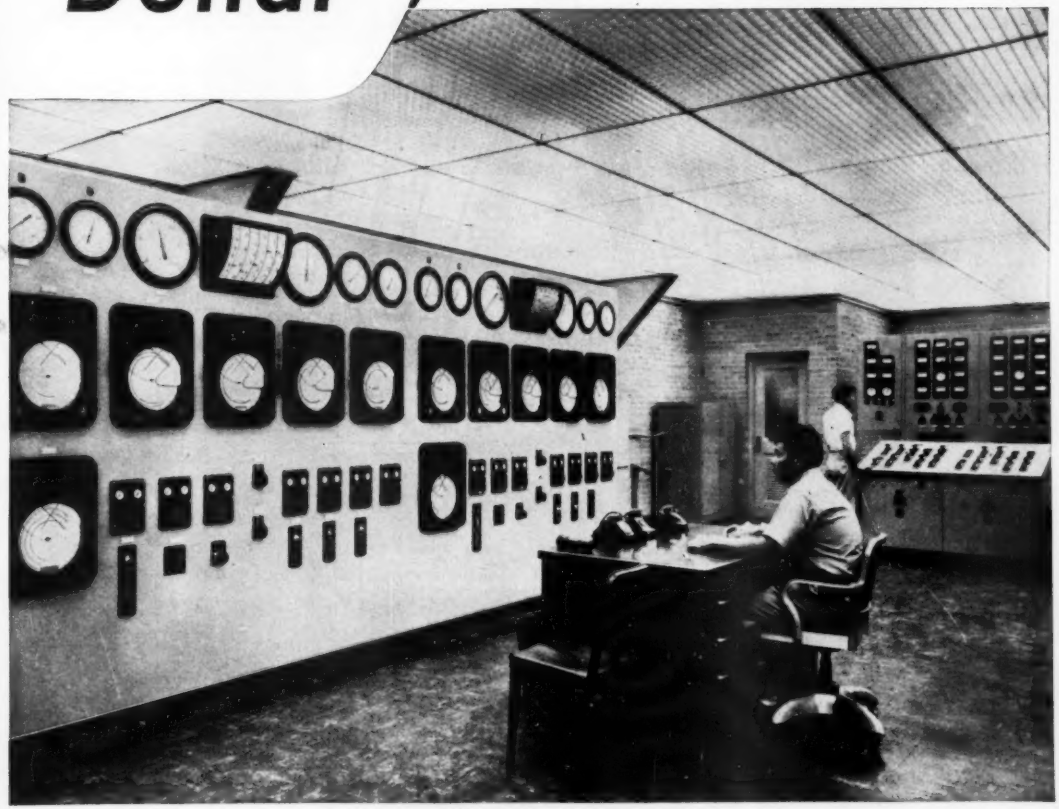
For better "boiler-room investment" efficiency—for more power per fuel dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

111-1

Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

INCREASE of YOUR Dollar



These Bailey Boiler Controls for Combustion, Feed Water, and Steam Temperature insure efficient operation of two 450,000 lb per hr, 1000 psi, 900 F, gas and oil fired boilers.

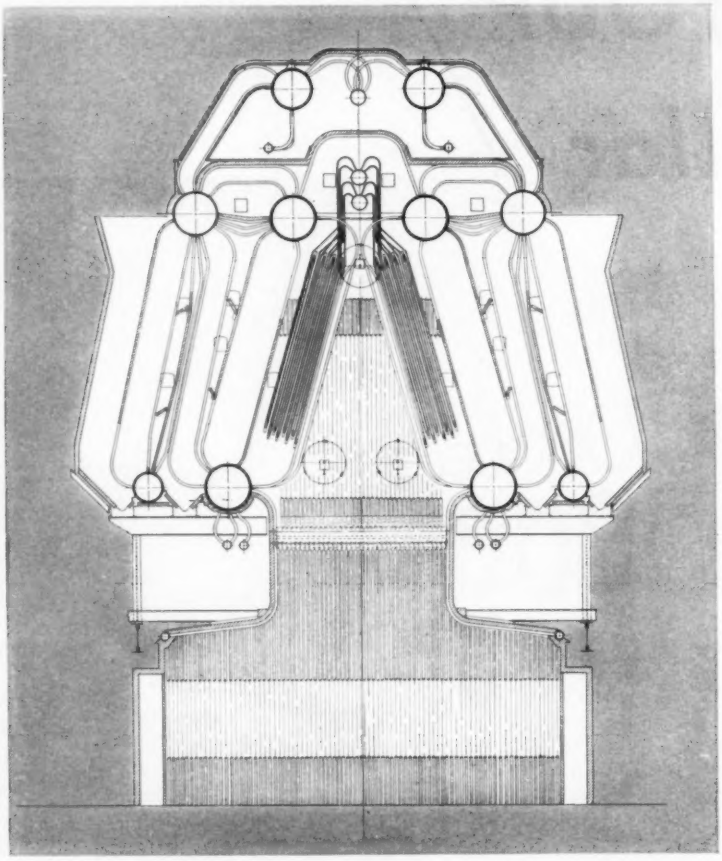
BAILEY METER COMPANY

1036 IVANHOE ROAD • CLEVELAND 10, OHIO

BAILEY METER COMPANY, LIMITED • MONTREAL, CANADA

BAILEY METERS

"... a remarkable job of



Nominal rating: 850,000 pounds per hour at 400 psi and 750° F. Each Ladd-type C-E boiler has six fully-automatic Vulcan long retractables installed in very congested space where temperatures are severe. The boilers are kept clean at all times. No hand lancing is needed.

VULCAN Automatic

keeping the boilers clean"

Here's what the Production Department reported . . . .

"The first year of operation of the Vulcan retractable soot blowers at . . . . . Station has been a decided success. A total of eighteen blowers (six per boiler) have been in daily service without the loss of a single lance . . .

". . . the soot blowers have done a remarkable job of keeping the boilers clean. Each . . . has been kept clean and in condition to exceed a million pounds of steam per hour rating at any time."

—— V ——

These three boilers had been in service almost twenty years. The original soot blowers—even when supplemented by daily hand lancing—had been unable to clean adequately the boiler and superheater tubes.

Narrow aisles and interferences from building steel and other equipment created a difficult installation problem, but Vulcan solved it. Just as Vulcan can solve your trickiest problem of keeping boilers clean.

VULCAN SOOT BLOWER DIVISION
Continental Foundry & Machine Company
DUBOIS, PENNSYLVANIA

At PLANT YATES of

. . . COPES APPLIED TO HYDRAULIC

GIVES PRECISE FEED AND LEVEL

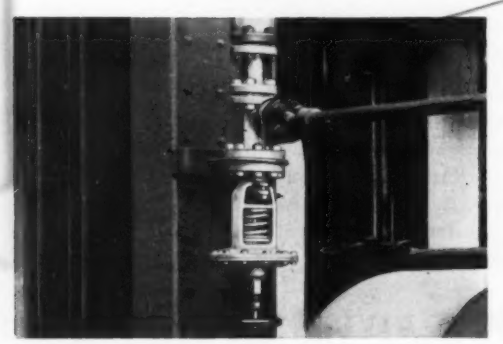
Remarkably close feed-flow and water-level control is being demonstrated daily by the COPES Balanced Flow Control at Plant Yates of Georgia Power Company, Newnan, Georgia. Units 1 and 2 went into service late in 1950.

Each unit includes a 3-drum, dry-bottom, radiant-type Combustion Engineering-Superheater boiler designed for a maximum continuous rating of 975,000 pounds per hour. Loads have been carried as high as 1,050,000—as low as 250,000—pounds of steam per hour.

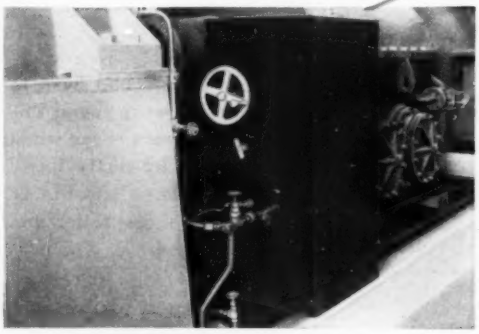
The COPES Control, applied through the hydraulic couplings of the feed pumps, matches feed flow almost perfectly to steam flow, and stabilizes water level within plus-or-minus one inch. Independent of meters and other controls, it can remain on full-automatic when they must be out of service for any reason. Duplicating COPES Control is on order for Unit 3, scheduled to start operation next winter.

NORTHERN EQUIPMENT DIVISION
Continental Foundry & Machine Company
711 GROVE DRIVE, ERIE, PENNSYLVANIA

***Headquarters for* Feed Water Regulators, Pump Governors, Differential Valves, Level Controls, Hi-Low Alarms, Reducing Valves, Desuperheaters**



COPES Recirculating Valve used with the Minimum Flow Control System to protect the pumps on light loads.



Air impulses from the COPES Balanced Flow Control actuate this controller on the hydraulic coupling to control the speed of each boiler feed pump.

COPES

BOILER FEED

GEORGIA POWER COMPANY

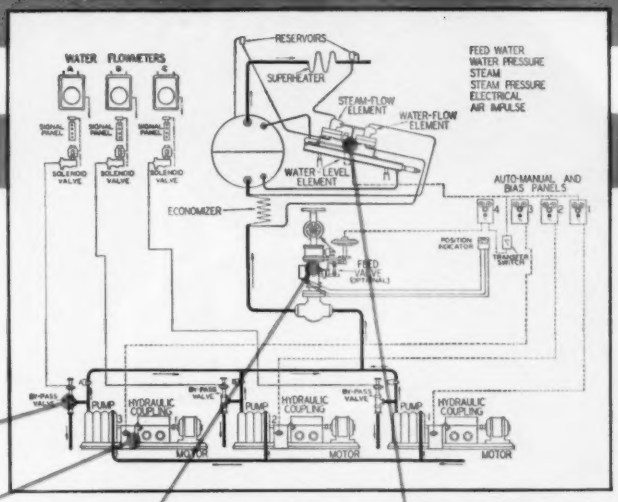
COUPLINGS

CONTROL

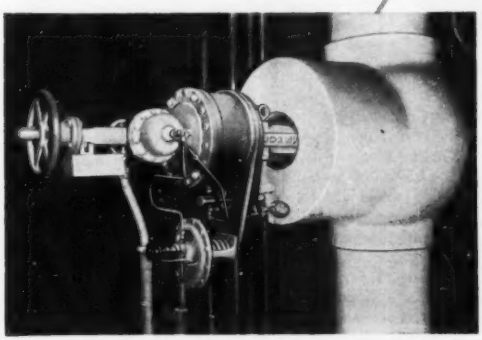
Shown schematically is the COPES Balanced Flow Control installed for each boiler at Plant Yates. Responsive to three influences—steam flow, feed flow and water level—the COPES applies air impulses to position the individual controller for the hydraulic coupling of each motor driven pump. Two pumps are normally paralleled, with the third on standby, but any pump can be cut in or out by pushing the button to start or stop its motor.

The feed valve is normally wide open, but can be cut into automatic service at any time.

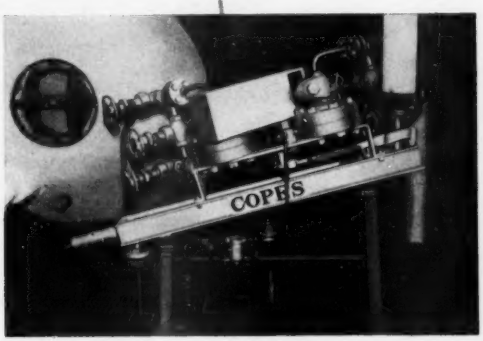
COPES Minimum Flow Control protects the pumps against overheating on light loads.



How well this system controls both feed flow and water level is shown by a new COPES Performance Report which also covers installations in two other Georgia Power Company plants. Charts are reproduced, as are boiler drawings and equipment photographs. *Write for Bulletin 489.*



The COPES Feed Valve, installed in a vertical line, is normally wide open but may quickly be placed on fully-automatic, if and when this is desired.



The COPES Balanced Flow Thermostat has steam-flow and water-level elements mounted rigidly on the frame of the water-level element. It is rugged.

WATER REGULATION

vision—with a past,

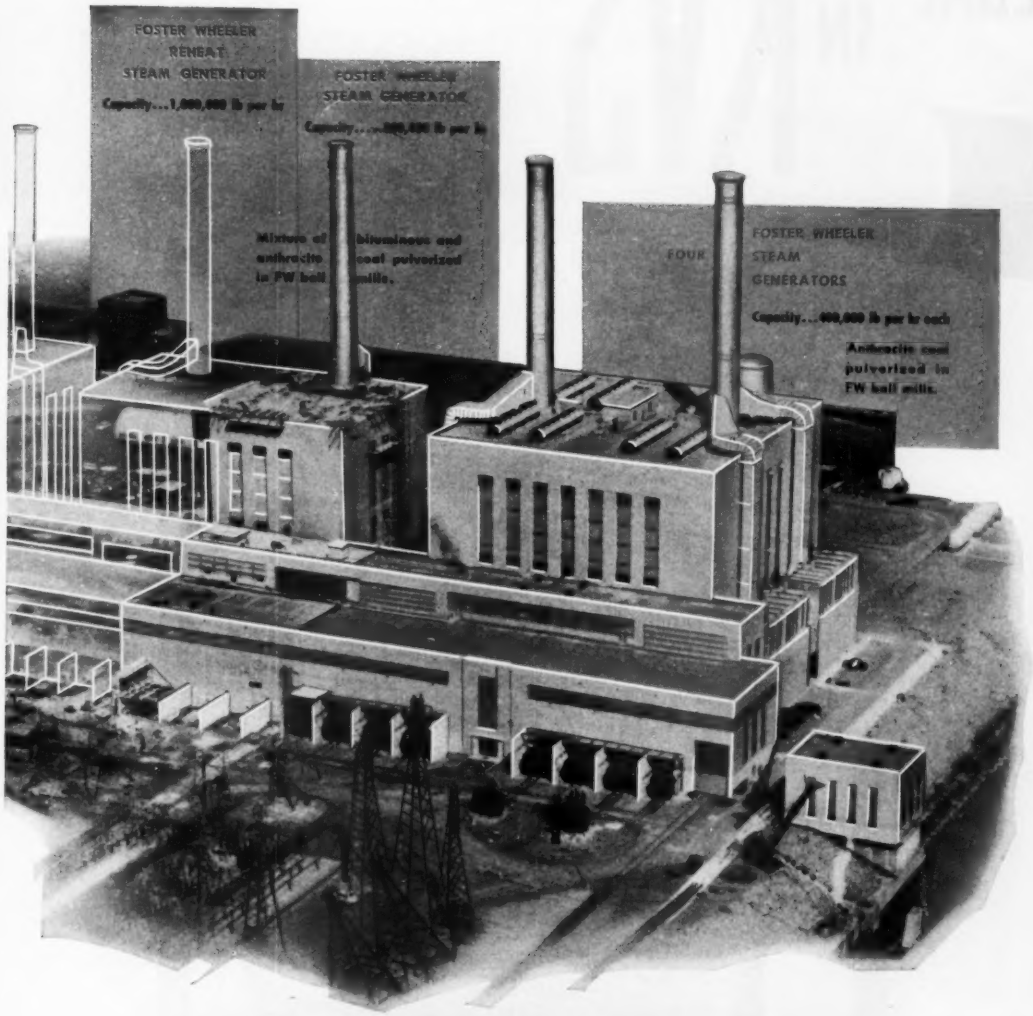
The original Sunbury Steam-Electric Station which was built by Thomas A. Edison in 1883.

The vision began to take form on Independence Day, July 4, 1883 at Sunbury, Pa. when Thomas A. Edison threw the switch of the first commercial steam-electric station in the world. This was one of the epochal events foreshadowing the scientific, industrial, and economic miracles of the 20th century. The new Sunbury Steam-Electric Station near Sunbury, Pa. reflects both the tradition of our American past and the hope of tomorrow as its fine buildings emerge from the blueprint stage to provide an abundant source of power for factories, offices, farms, and homes in Central Eastern Pennsylvania.

The earliest section which houses four Foster Wheeler 400,000 lb per hr steam generators providing steam for two 75,000 kw turbine generators is the world's largest power plant burning pulverized anthracite. The first extension houses a 100,000 kw turbine generator and an 800,000 lb per hr Foster Wheeler steam generator. Engineering is under way for the installation of an additional Foster Wheeler 1,000,000 lb per hr reheat steam generator designed to serve a 125,000 kw unit. When ultimately completed, the station is expected to have a capacity of more than 700,000 kw.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW

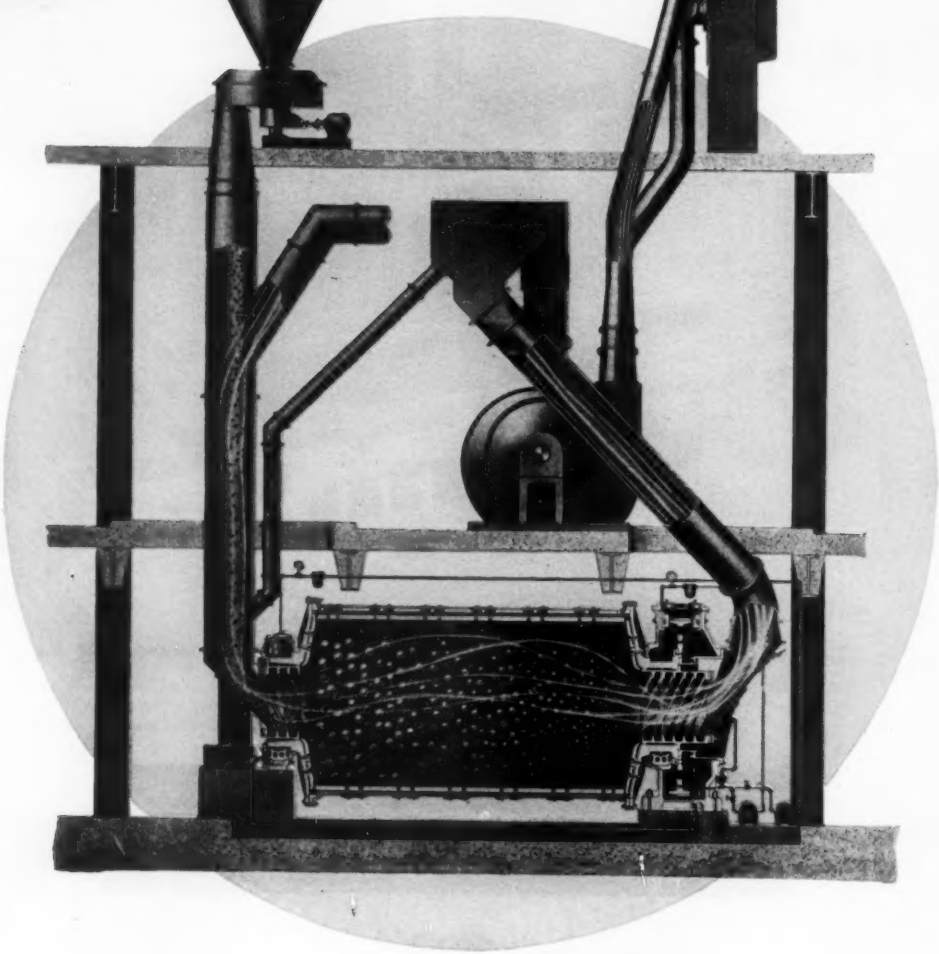
present, and future



YORK 6, N. Y.

FOSTER WHEELER

PULVERIZE *any* COAL IN KVS AIR SWEPT TUBE MILLS



...burn it like a gas and save money—

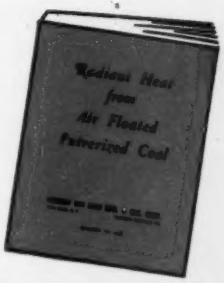
Coal can be made to burn like a gas by pulverizing it to 85% through 200 mesh screen fineness . . . in a KVS Air Swept Tube Mill.

Provide coal . . . any coal . . . and specify KVS pulverizing and firing equipment. A superfine fuel with complete control of firing rate is then at your command.

KVS ENGINEERING SERVICE

Our engineers will furnish complete boiler designs for your steam requirements. Let us help you reduce your operating and fuel costs with KVS pulverized coal firing and KVS steam generators.

Ask for a copy of 97-page Engineering Bulletin No. 44-B containing valuable information on preparation of pulverized fuel and steam generating plants.



Kennedy Products

Kennedy-Van Saun

MANUFACTURING AND ENGINEERING CORPORATION

2 PARK AVENUE • NEW YORK 16, N. Y.

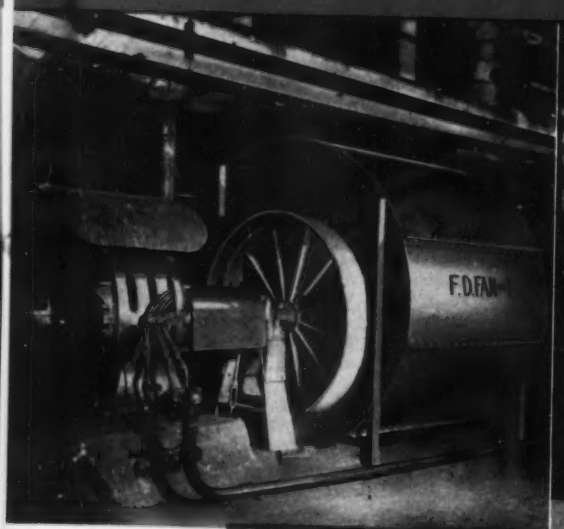
FACTORIES: DANVILLE, PA.

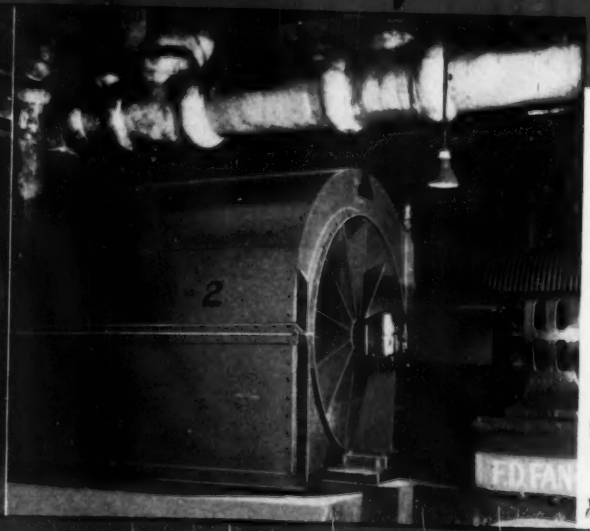
CANADA • ENGLAND • FRANCE • AUSTRALIA

Further Proof

"Buffalo" DRAFT LAST LONGER

And Save Money!





BUFFALO FORGE

488 BROADWAY, BUFFALO, NEW YORK

That FANS

. . . THESE FANS IN CHAMPION PAPER AND FIBRE CO.'S OLD BOILER PLANT WERE BUILT IN 1917!

● Built in 1917, installed in Champion's boiler house in 1925, these "Buffalo" Forced Draft Fans were on regular service until 1931 . . . and were still in good enough condition to be on standby service ever since!

As power engineers know, this is an endurance record for forced draft fans. It is not a lone case. "Buffalo" installations, industry-wide have been saving money for their owners through endurance — less trouble on the power run — fewer timeouts — longer life. Why not write for Bulletin 3750 and see what up-to-date "Buffalo" draft fans offer you?

COMPANY

WRITE FOR YOUR COPY

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Branch Offices in all Principal Cities

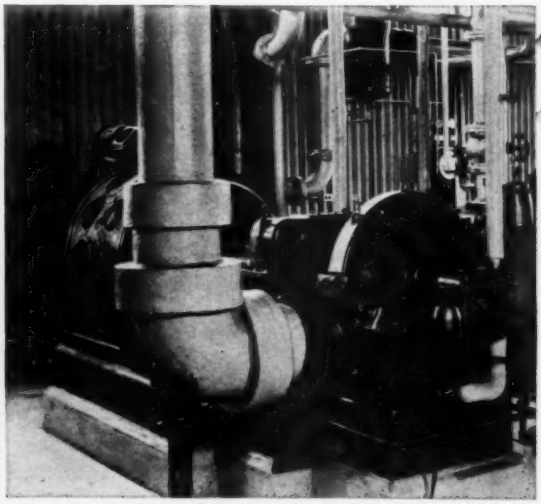
WHY STANDARD DP TURBINE DRIVES FIT ALMOST ANY APPLICATION

Here's a turbine designed by turbine users. It incorporates the features asked for by hundreds of operators interviewed in an exhaustive survey. They told General Electric they wanted a mechanical-drive turbine that would fit many types of applications—continuous process, standby, indoor, outdoor, equipment drive, generator drive, etc.

The DP answers these varied requirements with special features that are included as standard parts. For instance, you get hydraulic governing to meet critical accuracy requirements, totally enclosed construction that allows installation in hazardous atmospheres, pressure lubrication for dependable, continuous operation. These advantages are included at no extra cost—the DP is priced as a standard.

If you have steam available, the DP turbine can work profitably for you. You'll discover how its standard design gives you wide application flexibility, makes possible real savings in maintenance costs. The DP's operating record proves its reliability when there's a tough job to be done.

OUTDOOR INSTALLATIONS—No need to make special modifications when you move a DP out of doors. Totally enclosed governing system operating in its own oil atmosphere eliminates possibility of rusting or corrosion. You can operate a DP in hazardous atmospheres. Positive acting, non-sparking emergency governor protects the DP turbine against overspeed.



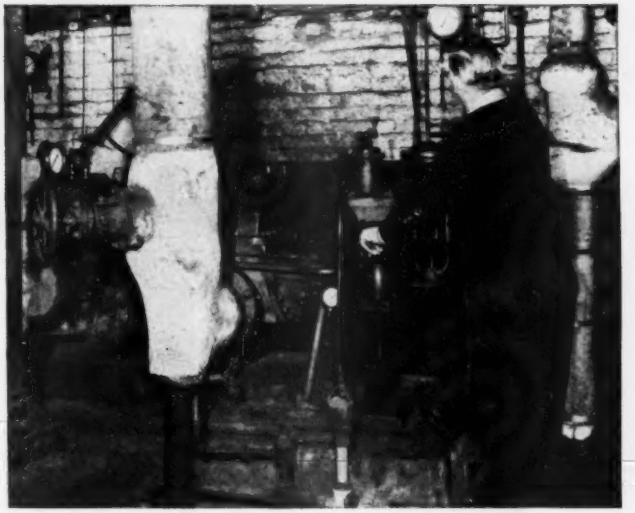
PRECISION GOVERNING—accurate enough for generator drives—is yours with the DP's hydraulic system. Regulation is 6 per cent with a 30 per cent range of speed adjustment. For process governing, regulator control is available.

Ask your General Electric representative for full details about the DP mechanical-drive turbine, or write for bulletin GEA-4955. General Electric Company, Schenectady 5, New York.

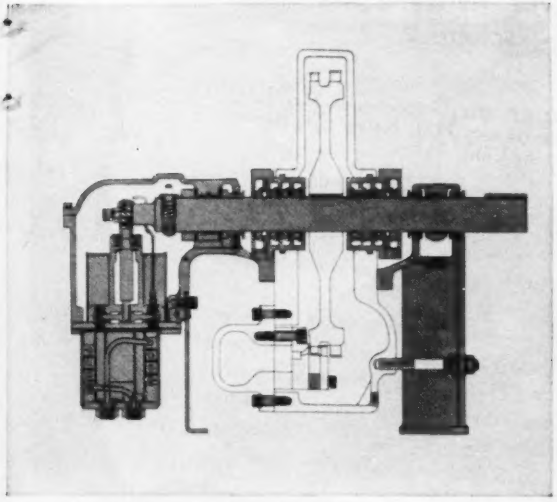
GENERAL ELECTRIC

252-50

MECHANICAL-DRIVE TURBINES

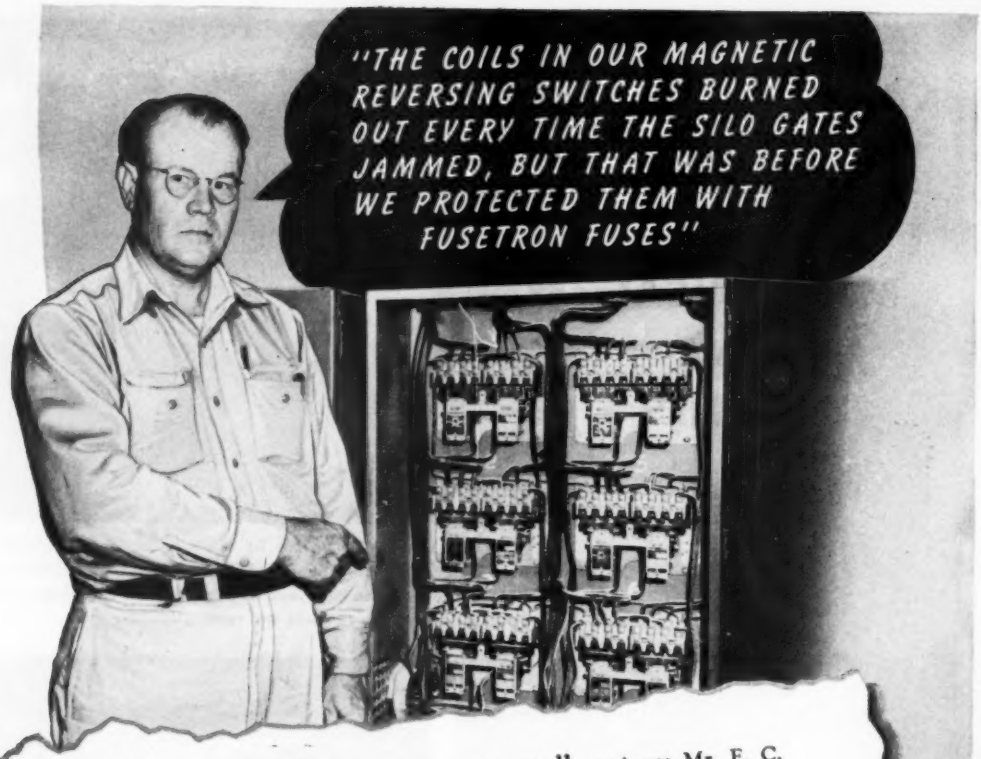


DEPENDABILITY is built into the DP. Positive lubrication through automotive-type bearings adds years to the life of the turbine. Special steel nozzle plate, self-lubricating graphite packings, and Monel-sprayed shaft are examples of design features that spell reliability.



APPLICATION FLEXIBILITY As the shaded parts in the diagram illustrate, most DP parts are identical on all frame sizes and ratings. In this way, you can adapt a DP for different job requirements with only minor changes. A different nozzle plate gives you a new horsepower output. A change in governor gears provides a new speed range. DP's are rated from 10 to 1200 HP and 1000 to 5000 rpm, and with slight modification, can deliver up to 2000 HP and 10,000 rpm. During a change in plant operation, the DP's flexibility will save you money.

EASY MAINTENANCE Because most parts are interchangeable on all models, spares can be stocked at low cost. A spare parts kit, containing 91 items, can be obtained with the turbine. This simple method of stocking spares lowers maintenance costs and provides protection for several DP's in your plant. All models, regardless of frame size, horsepower, or speed ratings, have identical shaft height, keyways, and coupling fits. Thus, installation problems are simplified; you can move these center-line supported units from job to job without a custom line-up.


"THE COILS IN OUR MAGNETIC REVERSING SWITCHES BURNED OUT EVERY TIME THE SILO GATES JAMMED, BUT THAT WAS BEFORE WE PROTECTED THEM WITH FUSETRON FUSES"

"Sure! ***you can quote me,"*** **continues Mr. E. C. Willy, Chief Electrician, H. J. Kaiser Co., Radum Plant, Pleasanton, Calif.**

"In the past, we found magnetic reversing switches welded the main contacts when Silo Gates jammed. When reverse control operated, the armature could not properly engage, resulting in a burned out coil.

"The coils cost about $4.00 each, but most important was the substantial production loss each time the coil burned out.

"We now have 4/10 ampere Fusetron dual-element fuses installed to protect these coils. During the year 1950 we blew about 100 Fusetron fuses, but didn't lose any coils. This represents a saving of at least $400.00 in coils and kept me from being dragged out of bed at night, an occurrence that often happened before. Then, too, we can replace burned out Fusetron fuses much faster than we can replace coils, to say nothing of the valuable production time we save."

Facts about Fusetron *dual-element* Fuses

- The fuse link element opens on short-circuit — the thermal cutout element protects on overloads — the result, a fuse with tremendous time-lag and much less electrical resistance.
- They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.
- Made to the same dimensions as ordinary fuses — fit all standard fuse holders.
- Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.
- Their cost is surprisingly low.

FUSETRON

TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION

BUSS

"You too, can get 10 Point Protection by using Fusetron (DUAL-ELEMENT) Fuses"

1* Protect against short-circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

★ Fusetron Fuses have high interrupting capacity as shown by tests of Electrical Testing Laboratories of New York City in December 1947.

Don't Risk Losses!

One **destroyed** switch or panel . . .
One **needless** shutdown . . .
One **lost** motor . . .

May cost you far more than replacing every ordinary fuse with a Fusetron dual-element Fuse.

Mail the Coupon Now!

Bussmann Mfg. Co., University at Jefferson
St. Louis 7, Mo. (Division McGraw Electric Co.)

Please send me complete facts about FUSETRON dual-element Fuses.

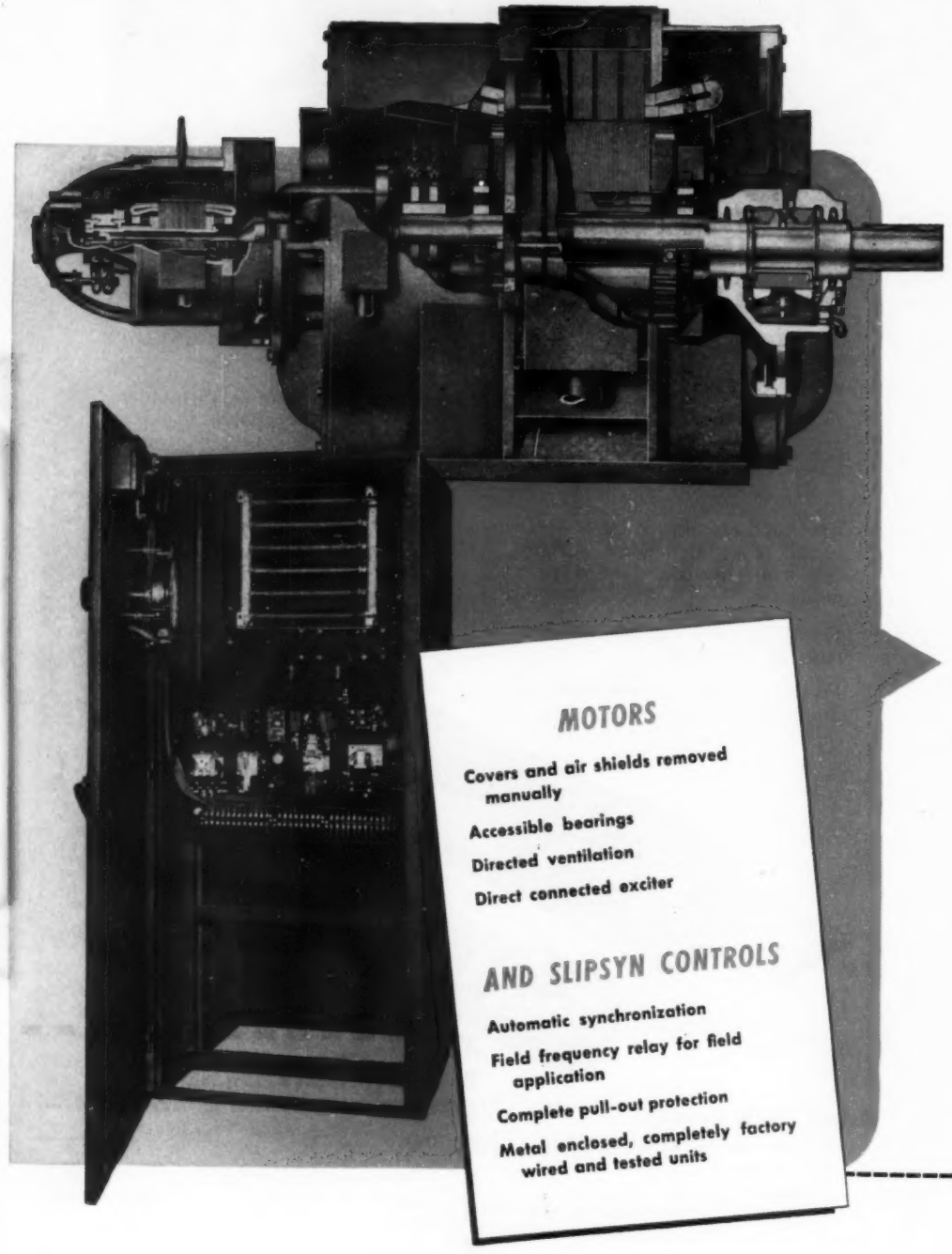
Name .....

Title .....

Company .....

Address .....

City and Zone ..... State 751



MOTORS

Covers and air shields removed manually

Accessible bearings

Directed ventilation

Direct connected exciter

AND SLIPSYN CONTROLS

Automatic synchronization

Field frequency relay for field application

Complete pull-out protection

Metal enclosed, completely factory wired and tested units

MORE POWER PER DOLLAR

with Westinghouse matched synchronous

Motors and Controls

You can improve your power factor and save money on power bills with Westinghouse synchronous motors. You can save more by matching the control to the motor. That way you get a completely co-ordinated system that makes sure you get the full savings available.

HIGH MOTOR EFFICIENCY is inherent in synchronous motor design. Losses are lower than in induction motors. In many cases, the first cost is less. Considering first cost, low maintenance expense and improvement of power factor, the synchronous motor supplies more power per dollar for many types of drives than any other motor.

REDUCED MAINTENANCE COSTS are the result of exclusive inspection and servicing features. Readily accessible split-sleeve bearings can be removed by hand. There's no top half of bearing bracket to remove. Brushes are readily available through the front bracket for both inspection and maintenance.

CONTROL IMPROVES PERFORMANCE Getting the motor started right every time . . . providing complete protection at all times are the basic functions of the Slipsyn motor control. Heart of the system is the ASR polarized slip frequency relay. It not only applies the field at the proper speed, but also at favorable rotor position for best performance. Welded all-steel cabinets with sectionalized compartments protect personnel. All live parts are completely enclosed. Attractive cabinet blends with modern plant equipment.

MORE DATA? Get in touch with your local Westinghouse representative for complete details. Ask for copies of B-4379 "Slipsyn Control", and DB-3200. Or write direct to Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

J-10352

YOU CAN BE SURE... IF IT'S

Westinghouse

LARGE SYNCHRONOUS MOTORS AND CONTROLS

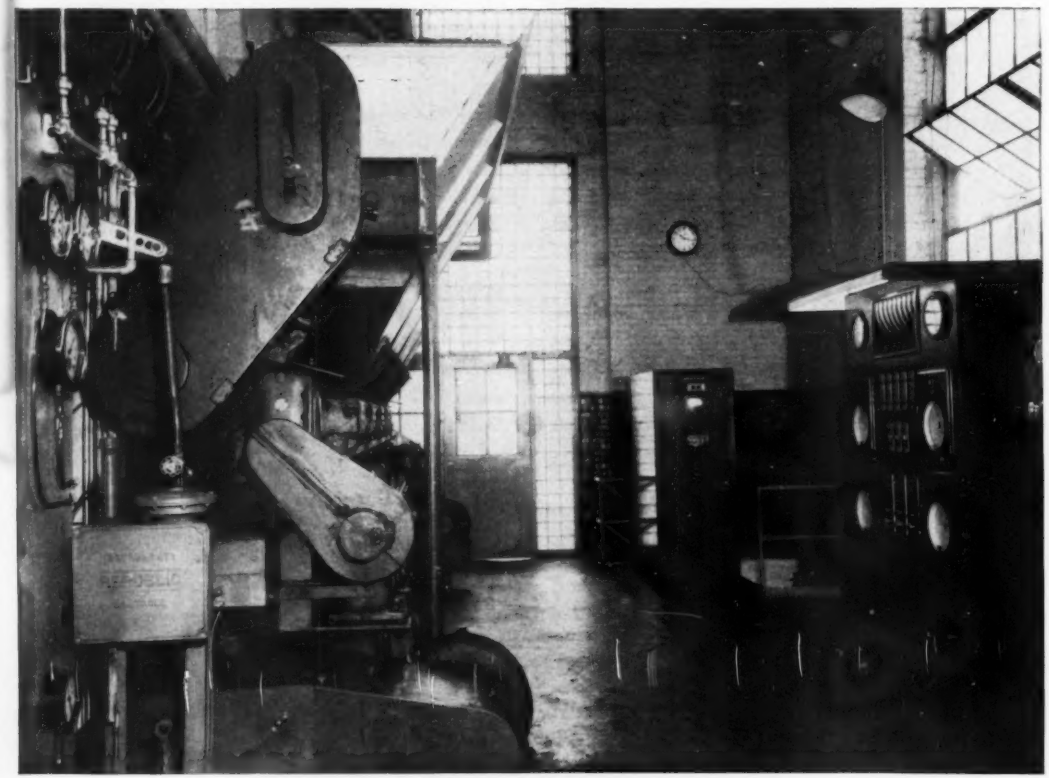
● the Municipal

Electric Light and Power Plant

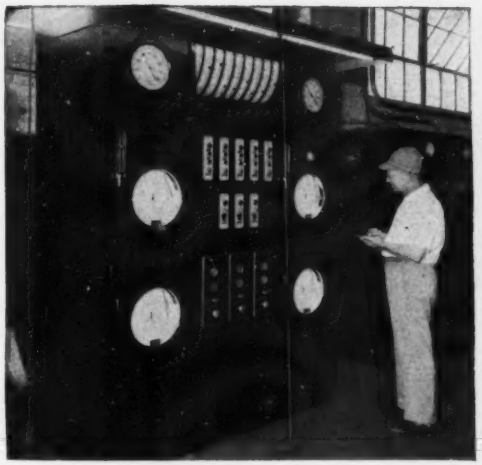
at Hannibal, Missouri

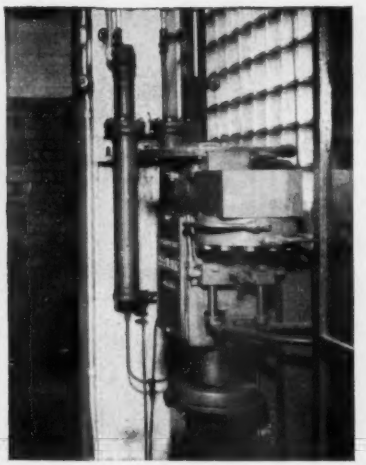
[the home of Mark Twain and his famous characters, Tom Sawyer and Huckelberry Finn]

HAS THE ANSWER TO



View of boiler room showing stokers and Republic boiler instrument and control panel.





Left: All essential boiler records and manual controls are centralized on the Republic boiler panel.

Right: Republic regulator controlling, in measured amounts, the air flow to the boiler.

LOWER STEAM COSTS

A REPUBLIC automatic combustion control system that operates their boiler at test standards, 24 hours a day, is the answer.

Installed at the Hannibal municipal plant is a modern three drum, 90,000 lb. per hour, 400 psi boiler with forced and induced draft fans and fired by a traveling grate spreader type stoker.

The REPUBLIC control system enables them to take full advantage of those economies which have been "built in" their boiler and its auxiliaries. It automatically increases and decreases simultaneously the fuel and air supply to the boiler in the correct amount to maintain constant steam pressure and in the correct ratio to maintain maximum combustion efficiency at all ratings.

The REPUBLIC combustion control system makes and co-ordinates these adjustments automatically, at the same time permits the operator to assume manual control from a centralized control point on the instrument panel whenever advisable.

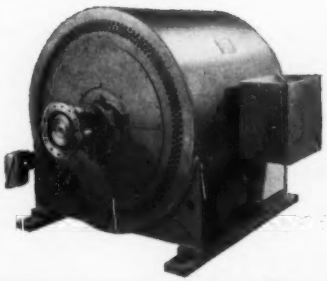
REPUBLIC combustion control systems are designed and built for all sizes of boilers — all types of fuel firing — all load conditions and any arrangement of draft equipment. We will be glad to supply full information on REPUBLIC Control Systems — just write for Data Book No. S-21.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

170,000 Hp Already Purchased

IN SIZES FROM 250 THROUGH 2500 HP

For really tough motor installations, central station engineers are turning to Allis-Chalmers large *tube-type* motors to get the peak reliability they know they need. Already over 170,000 hp of these totally-enclosed fan-cooled motors have been purchased. And practically 50% of the orders now are *reorders* from satisfied users.



Advantages offered by the *tube-type* air-to-air heat exchanger design of these motors include:

1. Full internal air circulation—for efficient, even cooling—makes large ratings practical.
2. Complete enclosure — protects stator core and other electrical parts from corrosive conditions.
3. Self-cleaning action — results from generous flow of outside air through smooth, straight cooling tubes.

For more information about these operation-proved TEFC motors, contact your Allis-Chalmers representative, or write for new bulletin 05B7150A. Allis-Chalmers, Milwaukee 1, Wisconsin. A-3416

ALLIS-CHALMERS

Above: Shown are four of the five big turbines of the Colorado Springs Municipal Utilities. NONPAREIL Turbine Oil helped operators "wash their hands" of oil-system maintenance troubles.

Left: J. J. Tyler (left), Standard Oil lubrication specialist, and W. J. Whelan, plant engineer, discuss the written guarantee given with each fill of NONPAREIL Turbine Oil.

Washed their hands of turbine-lubrication trouble!

NONPAREIL
TRADE MARK
Turbine Oil

Operators of the Colorado Springs Municipal Utilities had their hands full keeping oil systems clean in three big turbines. At least once a year, sludge and varnish had to be removed from the lubricating systems. Moreover, gradual deterioration of the lubricant used in the turbines made it necessary to replace fills of oil approximately every three years.

The recommendation of a Standard Oil lubrication specialist changed all of that. Operators took his advice and switched their turbines to NONPAREIL Turbine Oil.

Throughout ten years of operation, oil systems have stayed clean. The original fills of NONPAREIL have shown no appreciable deterioration, and neutralization numbers have remained below 0.10 KOH/gm. As a result, no fill of oil has needed to be replaced. The men of the Colorado Springs Municipal Utilities report: trouble-free lubrication by NONPAREIL has pared lubrication and maintenance costs to the bone! Since the switch to NONPAREIL, two new turbines have been added. Both of these units are lubricated with NONPAREIL Turbine Oil.

Trouble-free, low-cost lubrication is assured the Colorado Springs Municipal Utilities not only for 10 or 15 or 20 years but for the life of their turbines. This assurance is based on a written guarantee, given with each fill of oil to all NONPAREIL users, that NONPAREIL Turbine Oil will maintain a neutralization number below 0.15 KOH/gm. for the life of the turbine it lubricates. NONPAREIL has borne out its guarantee by having served, in individual turbines, for as long as 22 years without once being removed or replaced.

Ask a Standard Oil lubrication specialist to show you actual case histories from utility plants where NONPAREIL has reduced lubrication costs as much as 65%. You can reach a lubrication specialist by phoning your local Standard Oil Company (Indiana) office. Or, write:

Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA)

STANDARD

Cut-away view of factory-lubricated Pierce torque converter transmission governor.

Left to right: F. C. Hess, Standard Oil lubrication specialist, W. E. Benjamin, Pierce Governor Company engineer, and A. C. Gartley, Standard Oil Lubrication Engineer, discuss vital part played by STANOLITH Grease in pre-lubrication of Pierce governors.

Elected for governor job . . .

TO INSURE trouble-free lubrication of their product in the field, officials of Pierce Governor Company, Inc., Anderson, Indiana, initiated the production of a factory-lubricated sealed unit type governor.

A special grease was found that did the job, but as production of the sealed units mounted, this grease became a costly production item. That's when STANOLITH Grease, recommended by a Standard Oil Lubrication Specialist, was tried. In test block runs simulating 10,000 hours of actual operation, at speeds ranging up to 4,000 RPM and temperatures from 150°F. to 200°F., STANOLITH did an even better job than the original lubricant.

STANOLITH factory-lubricated governors now have been in service for over eight months with no troubles resulting from bearing failures, overheating, or leakage of the lubricant. STANOLITH's lower cost has been an added advantage.

STANOLITH
TRADE MARK
Greases

This is one of many success stories reported by users of STANOLITH. For the beginning of your own lubrication success story, call your local Standard Oil (Indiana) office for the services of a lubrication specialist.

Standard Oil Company (Indiana), 910 South Michigan Ave., Chicago 80, Illinois.

What's YOUR problem?

F. C. Hess, of Standard Oil's Indianapolis, Indiana, office, is the Standard Oil lubrication specialist who recommended STANOLITH to operators of the Pierce Governor Company, Inc., enabling them to make an appreciable cut in production costs.

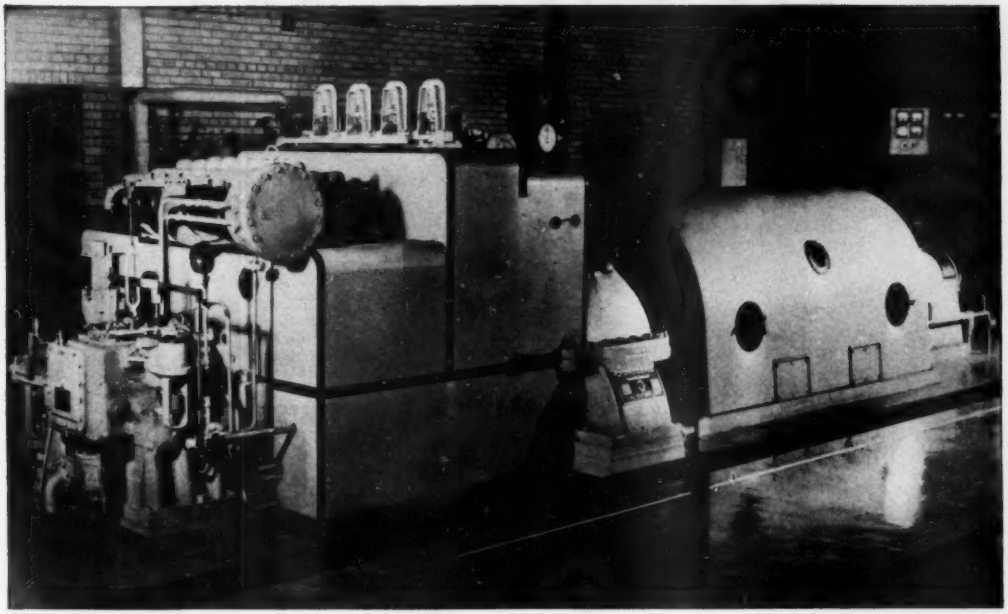
Throughout the Midwest there is a corps of specially trained, experienced lubrication specialists ready to give you prompt, on-the-spot help with any lubrication problem. Each of these men has been carefully trained in a Standard Oil Lubrication Engineering School. It's easy to get the services of a lubrication specialist — just phone or write to your local Standard Oil Company (Indiana) office. When he stops by to see you, ask him about the following fine Standard products:

STANOIL Industrial Oils—This general-purpose line of oils provides cleaner operation of hydraulic units and supplies effective lubrication in compressors, gear cases, and circulating systems. One or two grades can replace a wide variety of special oils and lubricants.

CALUMET Viscous Lubricants—On open gears and wire rope, these greases strongly resist washing and throw-off. Their superior wetting ability affords better coating of gears, better internal lubrication of wire rope.

STANORUST Rust Preventives—The eight grades of STANORUSTs form one of the most complete and effective lines of rust preventives on the market today. Each has been scientifically developed for its intended use. The grades range from a fingerprint remover to a heavy petrolatum that protects against corrosion for years under the most severe outdoor exposure.

STANDARD **STANDARD OIL COMPANY (INDIANA)**



Story of an Economy Drive

How the Worthington Steam Turbine Pays Dividends for the City of Litchfield

What happened at Litchfield, Minnesota, is a clue to a most economical power plant operation.

Originally, the Litchfield municipal power plant consisted of low-pressure boilers, a steam engine and a small turbine-generator unit. The exhaust steam is sold for municipal heating.

Next—a Diesel engine-driven generator was installed. The load grew, and finally, after a careful survey, it was decided to install a 3000-kw Worthington turbine generator and automatically extract steam for heating purposes.

Worthington builds steam turbines in all types and sizes—and turbine-generator sets up to 10,000-kw. For proof *there's more worth in Worthington*, call our nearest office or write to Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.

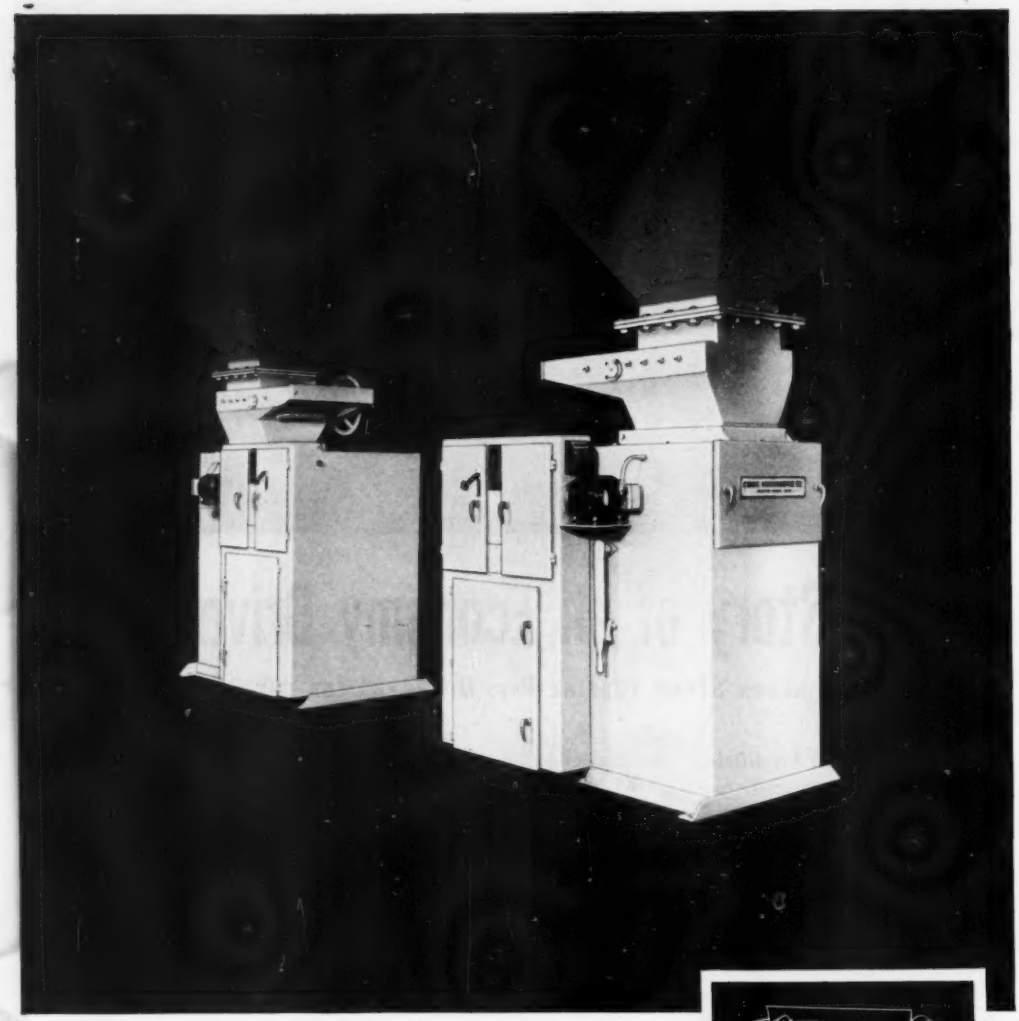
WORTHINGTON

STEAM TURBINE GENERATORS

T.I.9

A GREAT TEAM IN STEAM

S-E-Co. Coal Scales Are Reliable

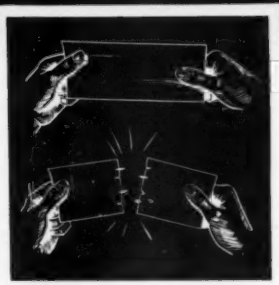


S-E-Co. Coal Scales are equipped with an endless feed belt which has no point of weakness. To demonstrate the great strength of an endless belt, try this yourself.

Cut a piece of paper into a strip 3" wide x 10" long, pull hard—note its strength.

Now cut two pieces 3" wide x 5" long and join them together with staples. Pull this spliced strip just a little and it pulls apart.

Only endless belts have enough strength for reliable coal scale operation. All **S-E-Co.** Coal Scales are equipped with endless belts.



SEND YOUR INQUIRY TO **STOCK EQUIPMENT COMPANY**

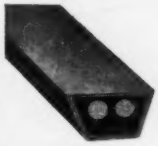
715 P HANNA BUILDING • CLEVELAND 15, OHIO

BIG or Small

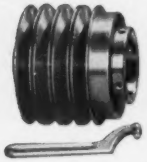
...EVERYTHING IN V-BELT DRIVES!

NON-STOCK SHEAVES — These sheaves are made to order from stock patterns for A, B, C, D, or E belts, 1 to 1000 hp. For further information check with your *Texrope* drive dealer or Allis-Chalmers Sales Office.

TEXROPE
Greatest Name in V-Belt Drives



SUPER-7 V-BELT — Famous grommet construction. No splices where failure can start. Rubber cushion supports rayon cord at pitch line. Sizes and sections to suit all operating conditions. All Standard sizes from stock.

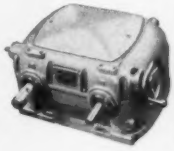


VARI-PITCH STANDARD SHEAVE — Speed range of 9% to 28% on drives of 1 to 300 horsepower, using A, B, C, D, or E belts. Two to 10 grooves. These sheaves are available in either motion control or stationary control.

AUTOMATIC *VARI-PITCH* SHEAVES — Offer stepless speed control . . . one to 40 hp . . . 2 to 1 speed range. Move motor forward to increase speed, and back to decrease. One hand does it while motor is running.

***MAGIC-GRIP* SHEAVES**— Fastest mounting sheave you can buy. Aligns easily . . . cannot shake loose. 1 to 12 grooves for A-B, B, C, and D belts. 1 to 250 hp. Stocked in many cities for immediate delivery.

***TEXSTEEL* SHEAVES** — Pressed steel sheaves for applications from ¼ to 25 horsepower. Light weight and rigid. 1 to 6 grooves, A or B belts. All sizes and bores are available for delivery from stock.



***VARI-PITCH* SPEED CHANGER**—Smooth, accurate speed control at turn of hand wheel. Machines operate at exactly the speed for best production. Stepless speed range: 3¾ to 1. Capacity: 1½ to 75 hp.

YOU CAN GET every V-belt drive component from the *Texrope* line: Constant speed drives; standard and wide range *Vari-Pitch* drives; speed changers; motor bases; and new or replacement long lasting *Super-7* V-belts.

Get Added Benefits

In addition, you get extra engineering skill both in the field and factory that comes from having more industrial V-belt installations than any other manufacturer.

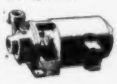
The world's greatest store of V-belt engineering knowledge has been condensed into a 120 page *Texrope* Pre-Engineered Drive Book. Covers 90% of all V-belt drive requirements. Ask your Allis-Chalmers Authorized Dealer or Sales Office for Bulletin 6956A, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3272

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

MOTORS — ½ to 25,000 hp and up. All types.

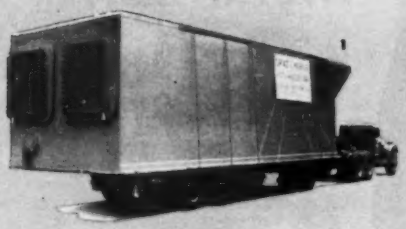
CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

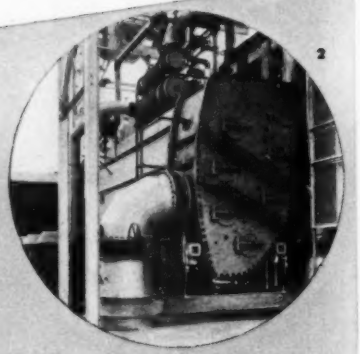


PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

Texrope, Super-7, Vari-Pitch, Texsteel, and Magic-Grip are Allis-Chalmers trademarks.

ALLIS-CHALMERS





flexibility of design

An 18,650 sq ft turbine-supporting Condenser serving a 20,000 kw turbo-generator in a New York State power plant.

One of two 32,500 sq ft Condensers serving a 65,000 kw side-exhaust turbo-generator at a power plant in Texas.

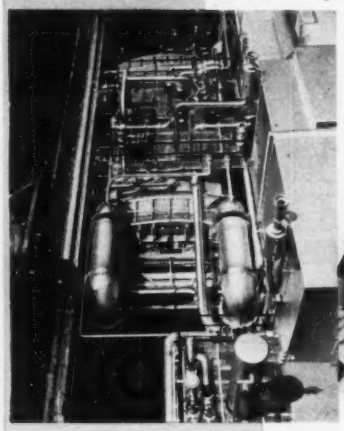
Foster Wheeler

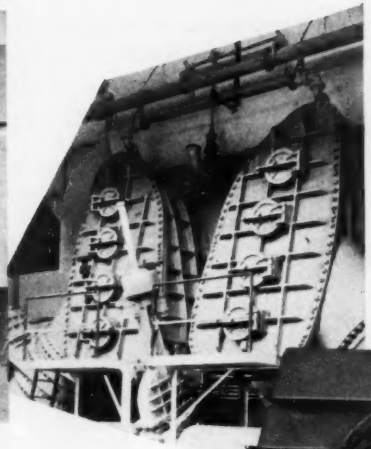
A 37,500 sq ft outdoor bowl type Condenser serving a 40,000 kw outdoor turbo-generator in Florida.

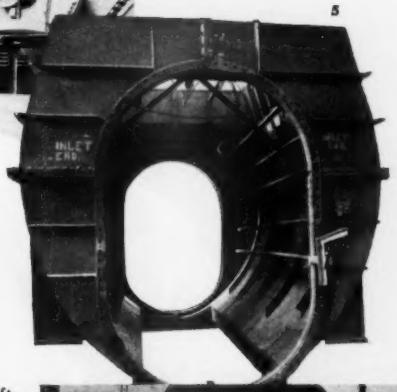
One of two 40,000 sq ft Condensers serving the 100,000 kw turbo-generators at a power plant on San Francisco Bay.

Shell of a 50,000 sq ft cross flow Condenser which will serve a 60,000 kw turbo-generator located outside of Dallas, Texas.

An 81,500 sq ft cross flow Condenser, one of two serving two 100,000 kw turbo-generators at a Georgia power plant.



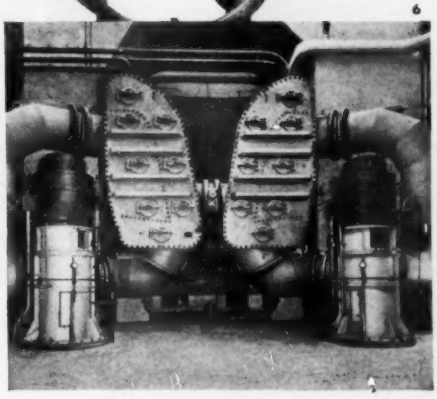




Condensers

Foster Wheeler Condensers, engineered to meet any condition at any location, range from 100 sq ft units serving a college campus to 100,000 sq ft installations serving the world's largest power plants.

Because space limitations and details of plant construction are also conditions affecting design, Foster Wheeler Condensers are built to meet the requirements of headroom, turbine support, outdoor installation or other factors to best suit each individual location.



Highly developed auxiliaries to assure top efficiency are also offered by Foster Wheeler. These include Steam Jet Vacuum Pumps, Condensate Pumps, and Circulating Pumps of Centrifugal and Axial Flow design.

For further details, write to

FOSTER WHEELER CORPORATION, 165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER

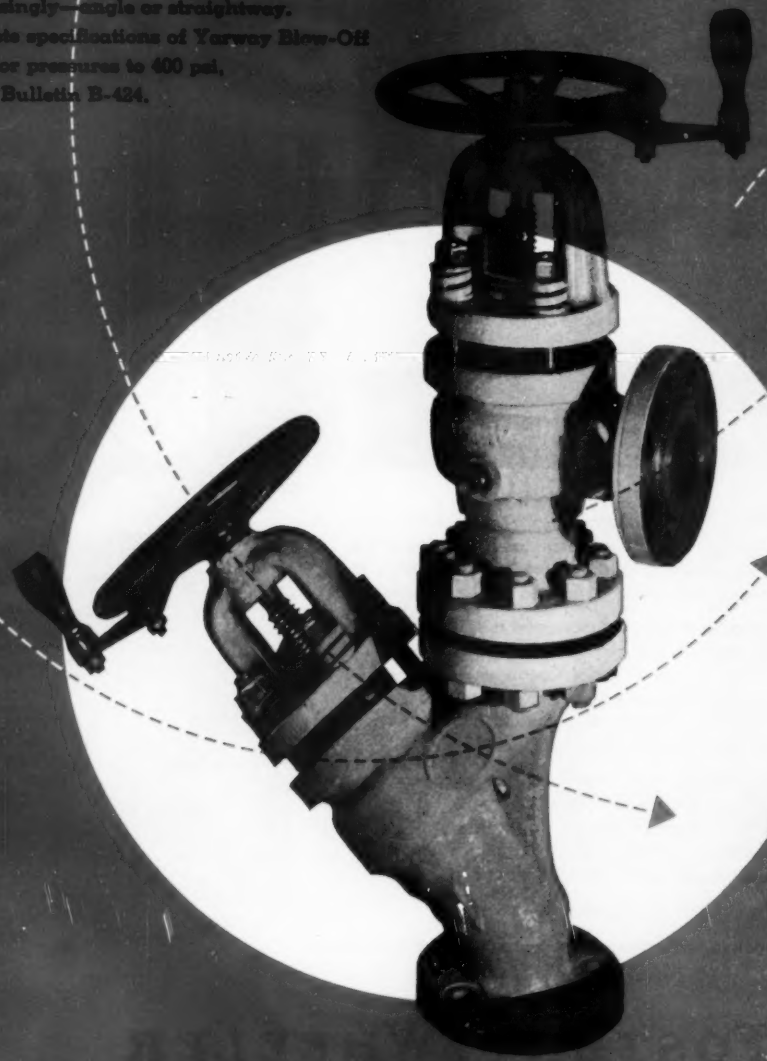
LOW PRESSURE?

Thousands of low pressure boiler plants rely on Yarway Seatless Blow-Off Valves to keep blow-down lines tight.

Famous balanced sliding plunger design eliminates a common source of blow-off valve leakage. There is no seat to score, wear, clog and leak.

Yarway Seatless Blow-Off Valves are furnished in tandem, as shown, or singly—angle or straightway.

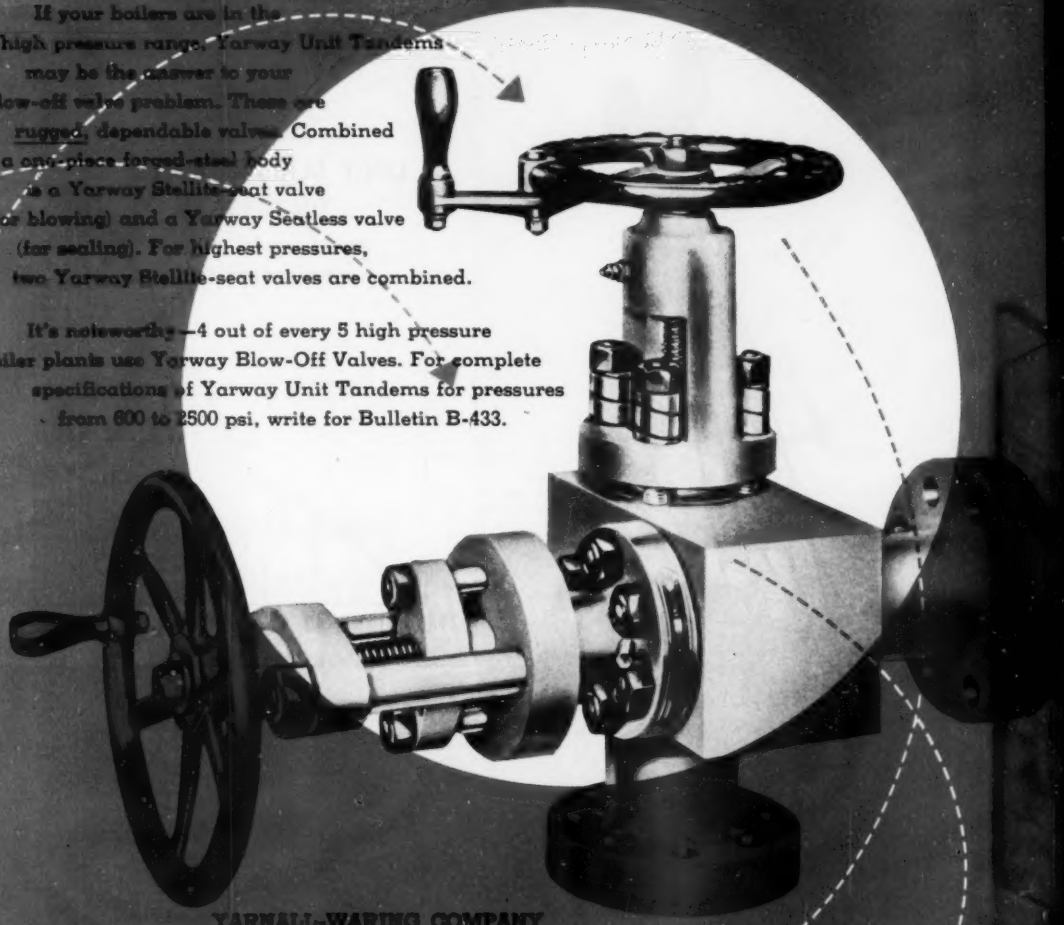
For complete specifications of Yarway Blow-Off Valves for pressures to 400 psi, write for Bulletin B-424.



HIGH PRESSURE?

If your boilers are in the high pressure range, Yarway Unit Tandems may be the answer to your blow-off valve problem. These are rugged, dependable valves. Combined in a one-piece forged-steel body is a Yarway Stellite-seat valve (for blowing) and a Yarway Seatless valve (for sealing). For highest pressures, two Yarway Stellite-seat valves are combined.

It's noteworthy—4 out of every 5 high pressure boiler plants use Yarway Blow-Off Valves. For complete specifications of Yarway Unit Tandems for pressures from 600 to 2500 psi, write for Bulletin B-433.



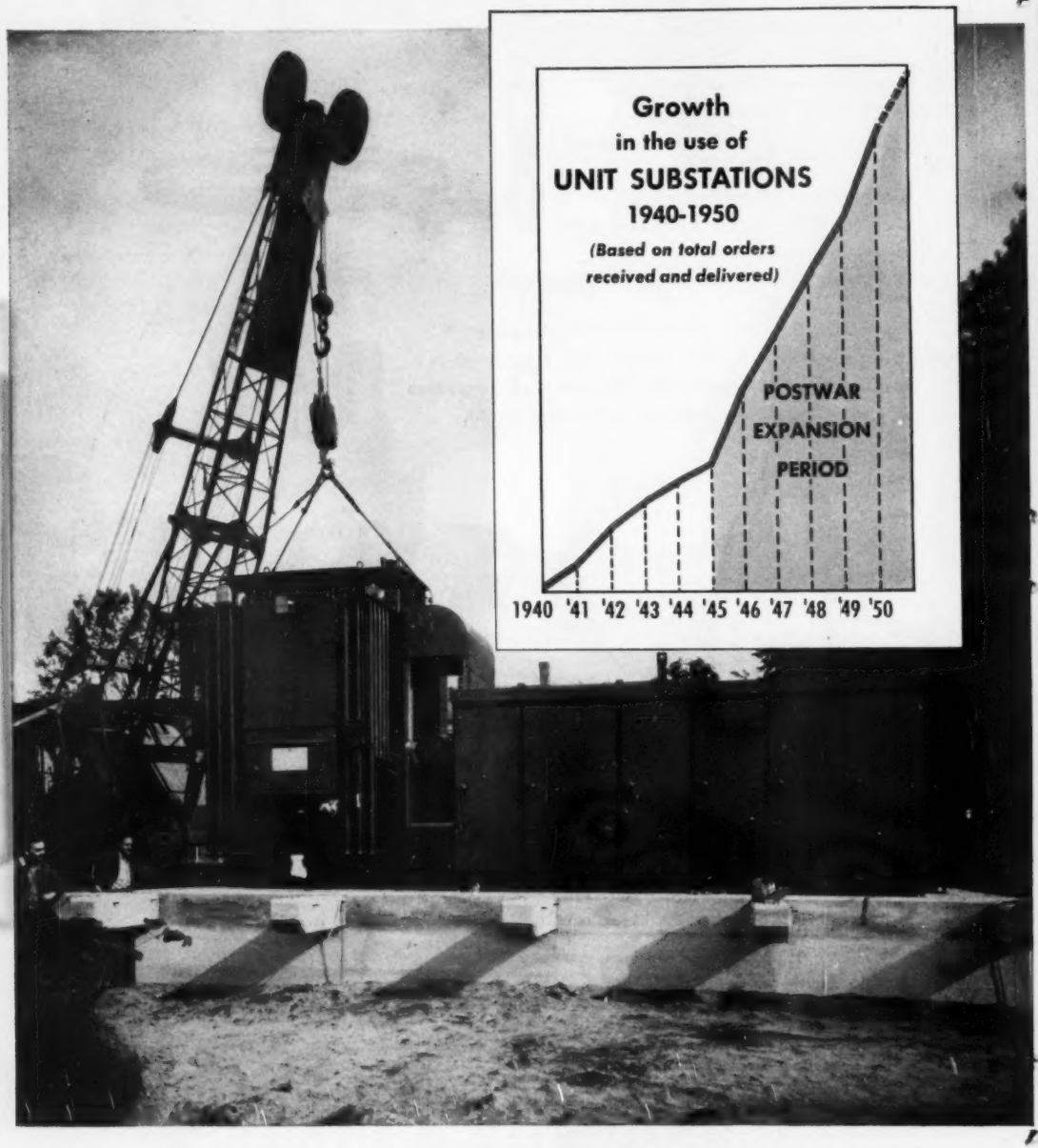
YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa. • Branch Offices in Principal Cities

YARWAY

BLOW-OFF VALVES

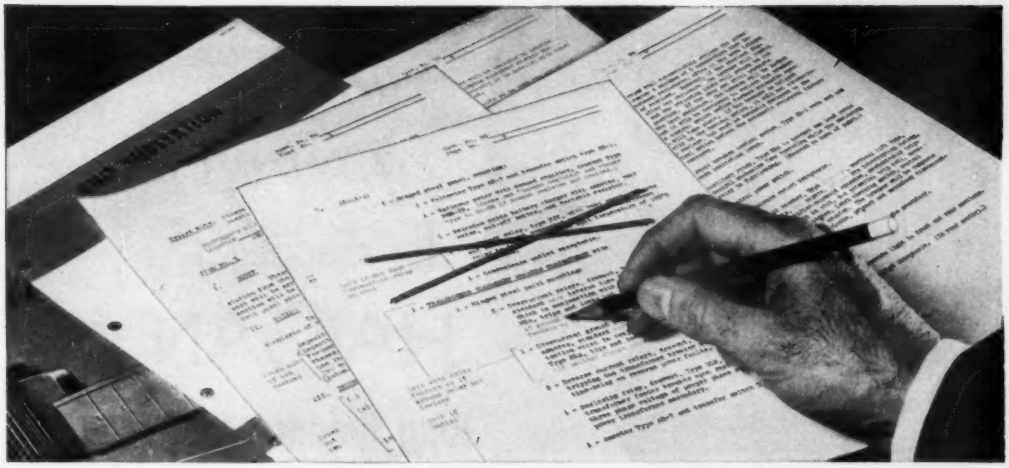
BLOW-DOWN TROUBLES—KEEP BOILERS ON THE 60

Unit Substations—Key to



QUICK INSTALLATION: G-E unit substations come to you complete—ready for operation. You merely build the foundations, position the equipment and connect to your incoming and outgoing lines. Photo shows G-E unit substation being installed on the system of the Western Massachusetts Electric Co.

Fast, Low-cost Expansion



Simplified purchasing, ease of installation help in meeting fast-growing loads . . .

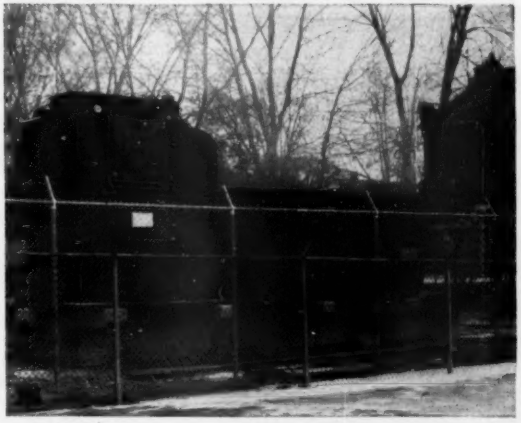
The rapid trend to factory-assembled unit substations—as shown in the chart at the left—seems sure to accelerate even more tomorrow.

Faced with the fastest-growing loads in history, utilities are finding these standardized, easy-to-install units one of their most valued tools in meeting expanding power demands quickly and at lowest cost.

Because of their great flexibility, compactness and adaptability, G-E unit substations are applicable to a wide variety of system arrangements. Standard, co-ordinated designs simplify planning and purchasing.

There's less worry about manpower and material problems. And proved, factory-engineered construction assures outstanding dependability. For full information, write for Bulletins GEA-3800 and GEA-4500. *General Electric Co., Schenectady 5, N. Y.*

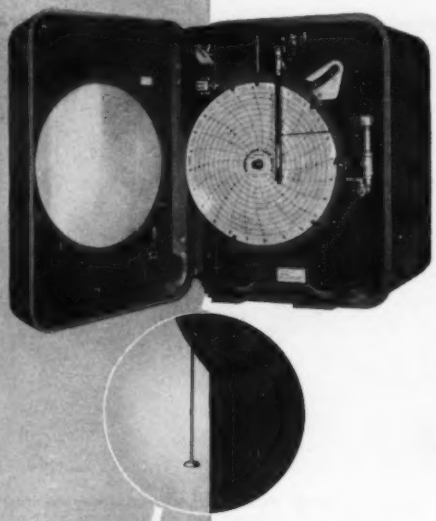
WEEKS SAVED IN ORDERING! Basic guide-form specifications for G-E unit substations are available to you, and using these, you merely add ratings and number of circuits required and cross out details not applicable. Weeks are saved in detailing layouts and piecemeal ordering. Your engineers have more time for other system work.



INSTALLED RIGHT AT LOAD: Compact, modern, attractive design of G-E unit substation enables it to be installed close to the load, even in many residential areas. Vital copper for secondary circuits is saved. The substation above was installed by the Western Massachusetts Electric Co. Note church in background.

321-74

GENERAL ELECTRIC



your equipment

for checking

HAGAN

Ring Balance Meters

The only equipment needed for checking a Hagan Ring Balance Meter is the set of calibrated check weights supplied with the meter.

Simply equalize the lead lines, check for zero, place check weights on the ring assembly and read the pen or pointer position.

Each weight is stamped with the equivalent in inches of water differential, and a simple calculation quickly establishes the relation between differential pressure and meter reading.

You can make this test under full static pressure, without high pressure manometers or other cumbersome testing equipment.

It is just as easy as it sounds.

HAGAN

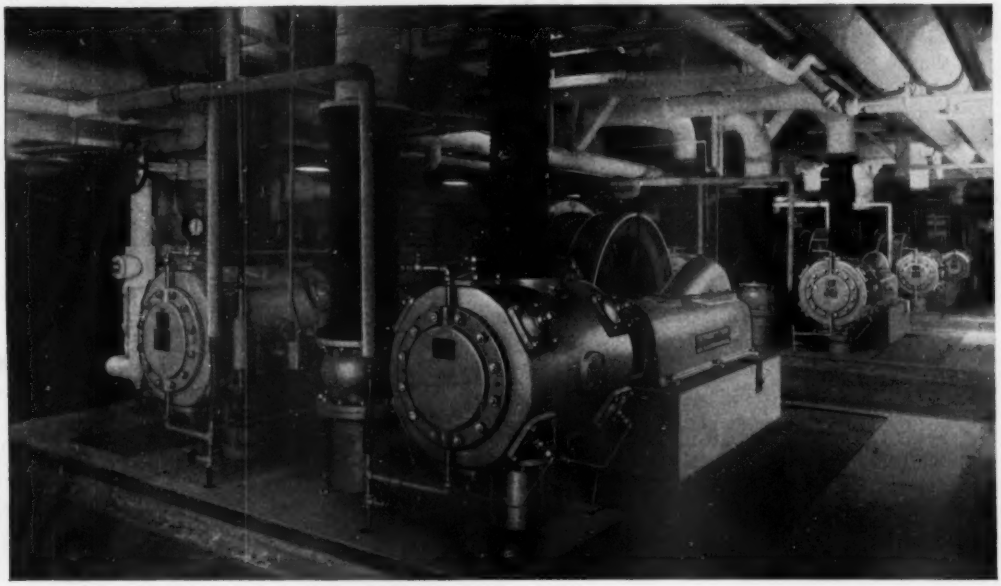
HAGAN CORPORATION

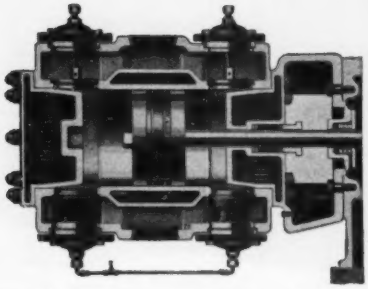
HAGAN BUILDING, PITTSBURGH 30, PA.

RING BALANCE HAGAN Ring Balance

combustion control systems . . . ring balance flow and pressure instruments

PRODUCTION OF CHLOROMYCETIN DEMANDS STERILE AIR





Advantages of Ingersoll-Rand "NL" Cylinders

The Ingersoll-Rand "NL" cylinder achieves oil-free compression without the use of tail rods or secondary crossheads. The weight of the piston is supported by graphitic-carbon wearing rings which prevent metallic contact between the piston and the honed cylinder bore. Compression rings are also carbon... metallic inner expanding rings giving the proper wall pressure. Because the carbon rings are self-lubricating, the need for any conventional lubricant is completely eliminated. Wearing rings can be adjusted to maintain the proper clearances.

Four Ingersoll-Rand "NL" Compressors Supply Air for Mold Growth in Parke, Davis & Co. Plant

In its Detroit plant, Parke, Davis & Co. is producing Chloromycetin by both biological and synthetic processes. The biological method includes an air-activated fermentation process that must be free from any contamination.

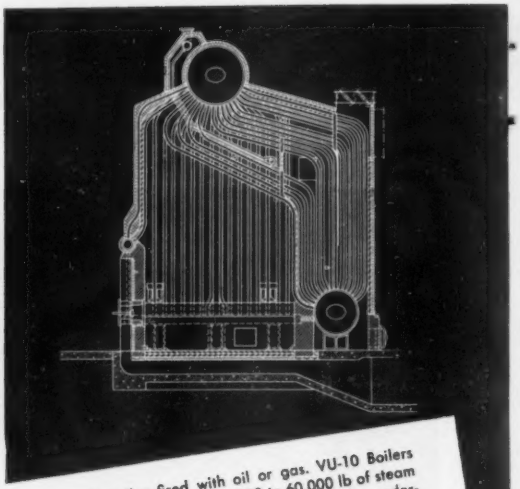
Air for activating the mold growth is compressed to about 40 psig by four Ingersoll-Rand XRE electric-driven compressors. Since any oil or other lubricant used in the compressor cylinders would contaminate this air, the compressors are fitted with Ingersoll-Rand "NL" *non-lubricated* cylinders. Other precautions to assure sterile, contamination-free air to the fermentation tanks include electrostatic filters on the compressor intake, moisture-removing aftercoolers, and stainless-steel mesh and carbon sterilizing filters.

For such services demanding oil-free air or gas, Ingersoll-Rand builds standard lines of compressors fitted with "NL" *non-lubricated* cylinders. Sizes range up to 300 hp for handling air or any gas up to a discharge pressure of 2500 psi. Consult Ingersoll-Rand engineers on how you can use "NL" compressors for your process or instrument-control.

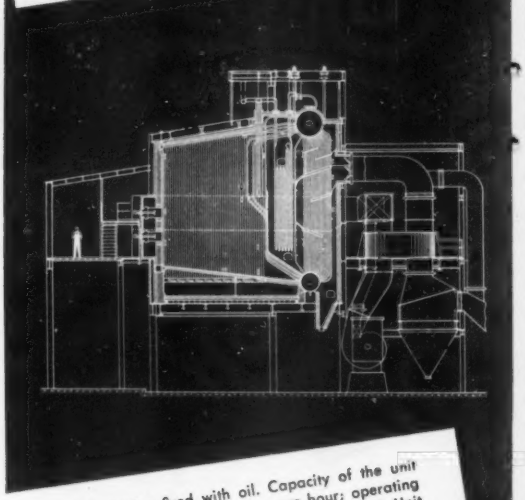
Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 387-1

One VU can start a family



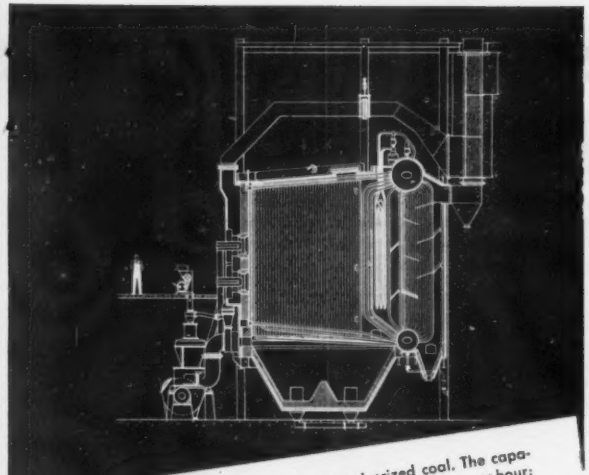
VU-10 Boiler fired with oil or gas. VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hour. They may also be fired by spreader, underfeed or traveling grate stokers.



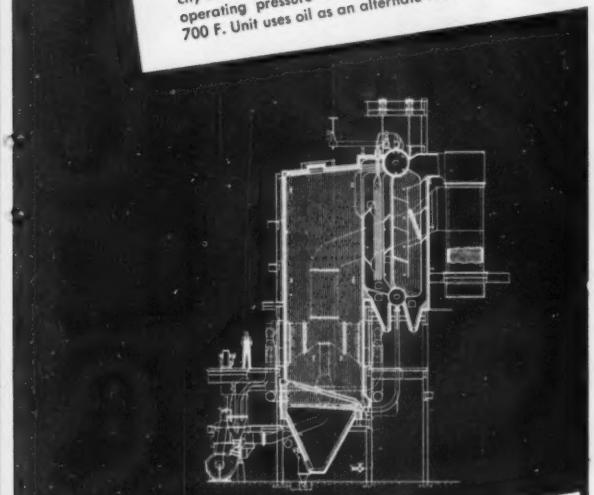
VU-50 Boiler fired with oil. Capacity of the unit shown is 235,000 lb of steam per hour; operating pressure—920 psi; steam temperature—905 F. Unit arranged for future pulverized coal firing if desired.

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



VU-50 Boiler fired with pulverized coal. The capacity of the unit shown is 60,000 lb of steam per hour; operating pressure—410 psi; steam temperature—700 F. Unit uses oil as an alternate fuel.



VU-50 Boiler tangentially fired with pulverized coal and/or blast furnace gas. Capacity of unit shown—125,000 lb of steam per hour; operating pressure—850 psi; steam temperature—750 F.

With fuel costing what it does today, it is more important than ever before to select a boiler that will assure the most efficient performance possible. That is why so many companies who watch steam costs closely have acquired sizable families of Vertical Unit Boilers. For example:

A Chemical Company ordered two VU Boilers in 1939. In 1946 five more were ordered for three of their other plants. In 1949 another was ordered for one of these same plants, and in 1950 two more units for a fifth plant. In 1951 three more units were ordered for still another plant — thirteen units for six plants in twelve years!

An Electric Utility Company ordered its first VU in 1941. In 1945 it ordered a second VU for a different plant. For another of its plants one unit was installed in 1946 and two more in 1947. In 1949 a VU was installed in a fourth plant, and in 1950 one was installed in a fifth plant. A total of seven boilers in five different plants.

A Sugar Company ordered two VU Boilers for one of its plants before the war. In 1946 it ordered a VU for a second plant. And in 1950 another VU was installed in this same plant.

A Steel Company now has a total of fourteen VU Boilers in four different plants. Starting with an installation of two units in the early thirties, it has reordered six times. The most recent installation of two units at one of its plants was completed in 1948.

* * *

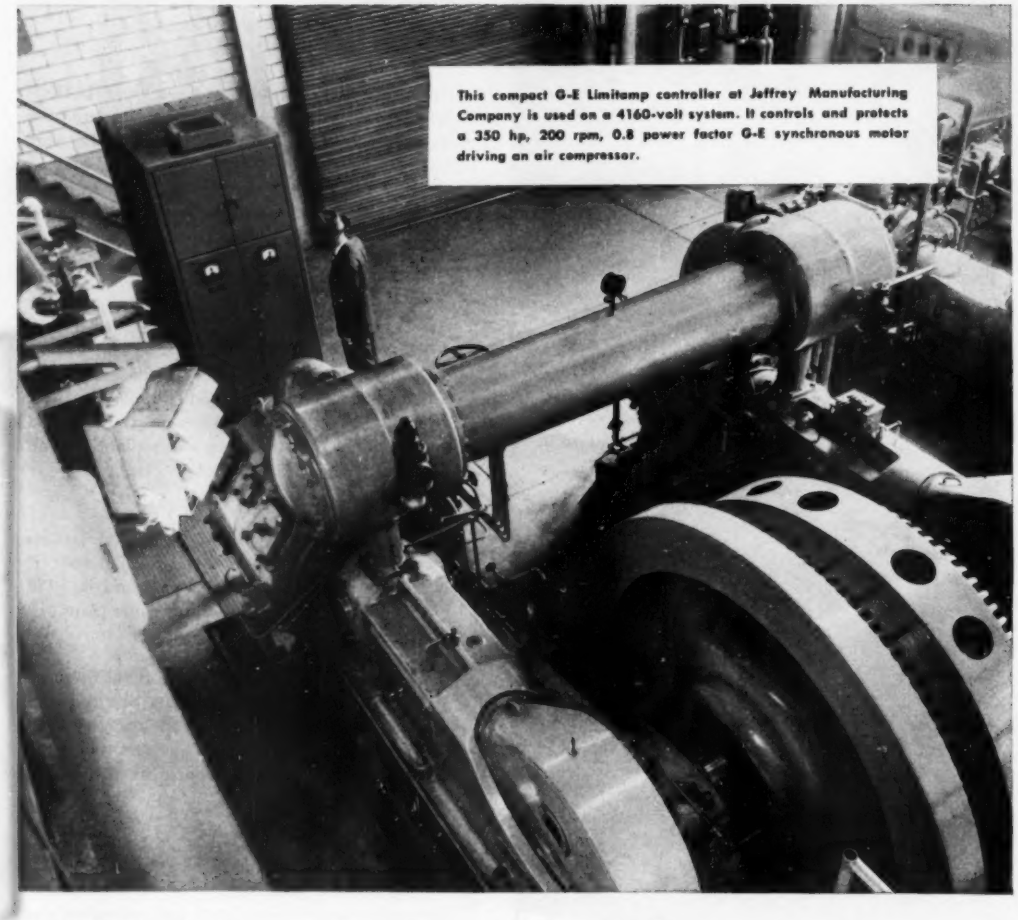
This is just a small sample of the hundreds of companies that have ordered and *reordered* the VU Unit. They have found *through their own experience* that the advanced design, sound construction and consistent reliability of the VU Unit mean *lower steam costs.* Once you have a VU in service you soon know why it is that so often *one* VU starts a family. B-494

— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

Jeffrey Manufacturing Uses G-E Limitamp Control



This compact G-E Limitamp controller at Jeffrey Manufacturing Company is used on a 4160-volt system. It controls and protects a 350 hp, 200 rpm, 0.8 power factor G-E synchronous motor driving an air compressor.

This high-voltage control meets a need for ample interrupting capacity, protection for operating personnel, good appearance and compactness

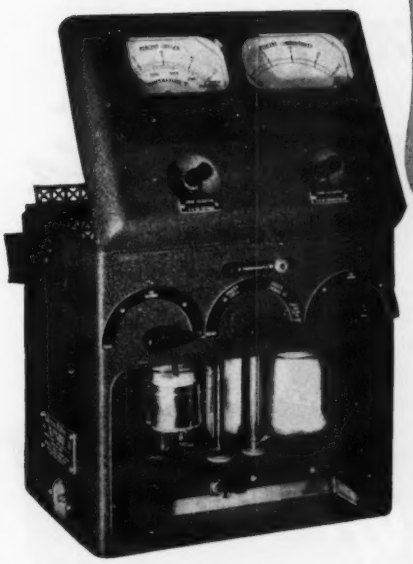
The addition of a large compressor for general plant use called for a synchronous motor and dependable high-interrupting-capacity control at Jeffery's modern power house. In addition to the accurate synchronization obtained with the new field control of this air-break Limitamp controller, and the factors mentioned above, Jeffrey likes the co-ordinated design of this G-E controller that is factory engineered and built. Such a compact, steel-enclosed controller is easily installed, requires little space—yet has all the features that provide protection for both equipment and personnel. And it's quickly inspected and maintained.

Rapid duty cycles do not affect the long life inherent in G-E Limitamp—now available in ratings up to 4800 volts with an interrupting capacity up to 250 mva. Shorts are cleared in less than half a cycle—offering positive protection for your expensive electric equipment. Write for more information on the new Limitamp controller—also available for squirrel cage and wound rotor motor control—in Bulletin GEA-5409. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

730-27

I SPY



Not an instrument you buy,
but a service we supply.
Write or call us today.

THE COMPLETE CITIES SERVICE LINE FOR THE METAL FABRICATING INDUSTRY INCLUDES

- Chillo Cutting Oils
- Trojan Greases
- Trojan Gear Oils
- Pacemaker T Hydraulic Oils
- Optimus Cylinder Oils
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Combustion Facts Fully Revealed by Fast, Simple Heat Prover Test

This scientific combustion analyzer—the Cities Service Heat Prover—gives you the real "inside" on furnace combustion conditions. Its plain, quick, accurate work lets you know:

How much excess oxygen is present

How much combustible matter is wasted

How much fuel you might save

Without endless trial-and-error you can proceed to conserve fuel and increase furnace output. This is substantiated by records made on all types of furnaces. See for yourself how productivity can be improved. Call or write *today* for a Cities Service Heat Prover demonstration... readily arranged in your plant. Or for further details return the coupon below.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

CITIES SERVICE OIL COMPANY
Sixty Wall Tower, Room 18
New York 5, N. Y.

Without obligation please send your booklet, "Combustion Control for Industry" and Heat Prover information.

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Company_____

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For Long Life under Severe Conditions

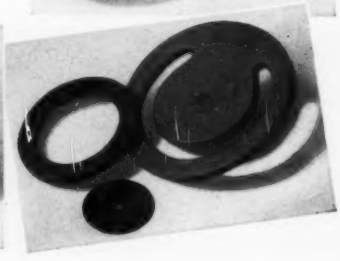
Garlock BITAN* LEATHER PACKINGS

Garlock BITAN* Leather Packings are tanned and treated by an exclusive Garlock process for the most severe leather packing applications. They operate satisfactorily at heavier pressures and higher temperatures than leathers of standard tannage and treatment.

In filling each order, the leather is properly tanned and treated for the particular service for which the finished product is to be used. All types or forms including: Molded Cups, "U" and "V" Packings, Flange or Hat Packings, Gaskets, Washers, and Discs. All sizes. Write for descriptive folder.

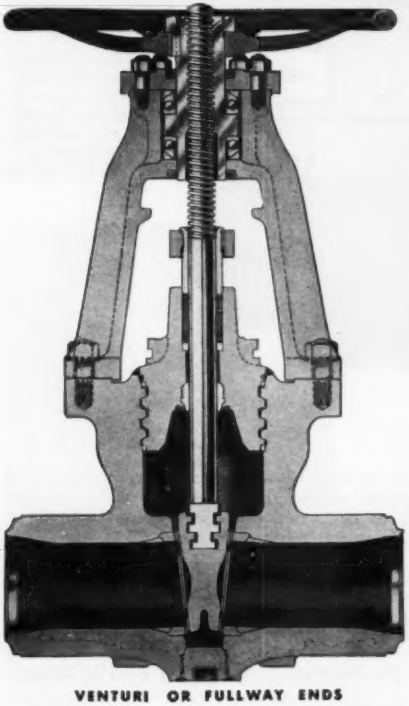
THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK.
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

*Reg. U. S. Pat. Off.



WITH LUNKENHEIMER

Breech Lock Valves



VENTURI OR FULLWAY ENDS

1500 LB. CAST-STEEL BREECH LOCK GATE VALVE

Your high-pressure, high-temperature lines are *safely* controlled with leak-proof Breech Lock steel valves, rated at 1500 lbs. S.P. and used in central power stations at pressures up to 2100 lbs. or 1050°F. The exclusive Breech Lock design follows the principle used on large guns, except that locking is not accomplished by a thread wedging action. Rather, four series of three heavy annular lugs on the body and in the bonnet intermesh and lock the two parts together. Stress is evenly distributed and the full internal pressure acting against the bonnet is carried by the breech lugs. Pressure tightness is maintained by sealing the seam or joint with a seal weld, which can be chipped out to remove the bonnet, if necessary.

The combination of locking lugs and seal weld possesses a strength and structural stability not attainable in any type of construction that must depend on some form of gasket for pressure-tightness. *Leakage is impossible, and maintenance never required.* In effect, the Breech Lock with Seal Weld has all the advantages of the Strength Welded Bonnet design, plus the added advantage of easy disassembly and reassembly in the field.

NOTE THESE ADVANTAGES:

Eliminates bonnet-joint leakage under the most severe operating conditions. No maintenance required. ★ Provides for ready disassembly and reassembly in the field. ★ Bonnet-joint tightness unaffected by rapid temperature changes. ★ No sealing surfaces to become damaged by corrosion, oxidation, or in disassembly, and thus prevent reassembly of a pressure-tight joint. ★ No flanges, gaskets, or bolts that will require periodic maintenance attention. ★ Seal weld makes a leak-proof joint. ★ Compactness of design reduces weight and bulkiness. ★ Contour of body and bonnet lends itself to good foundry practice, resulting in sound, dense castings.

Write for your copy of "Lunkenheimer Cast Steels," a brochure describing basic research in alloys for high-pressure, high-temperature valves. Address: The Lunkenheimer Company, Box 360A, Cincinnati 14, Ohio.

STEEL • IRON • BRONZE

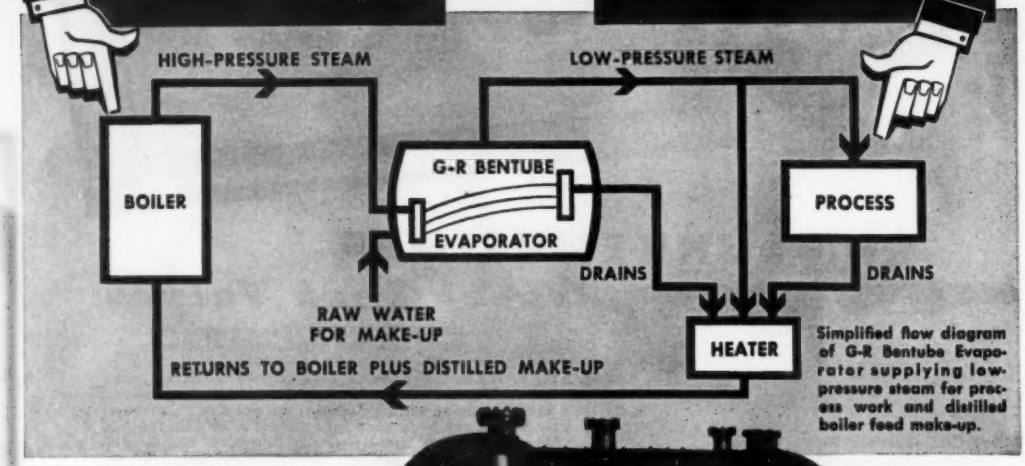
LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

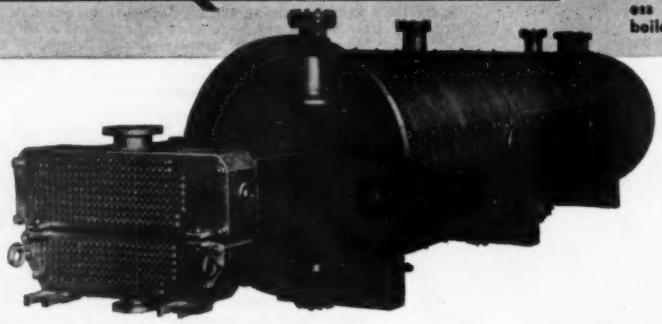
L-151-36

with a G-R Bentube Evaporator

PURE WATER for Boiler Feed Make-Up *plus* **STEAM for Process Work**



Simplified flow diagram of G-R Bentube Evaporator supplying low-pressure steam for process work and distilled boiler feed make-up.



This two-in-one unit can double as a 100% thermally efficient reducing valve and raw water purifier. Part of the vapor which it produces can be used as low-pressure steam for process work, while the remainder is condensed as distilled water for boiler feed make-up. The G-R "Reducing Valve" Evaporator wastes no heat . . . requires no chemicals.

For more than 50 years, G-R Evaporators have been proving their effectiveness and economy in marine and stationary installations, large and small. Today, they are in use in power generating stations, industrial and process plants all over the country, as well as on many hundreds of naval and merchant marine vessels . . . wherever pure water is a necessity.

The exclusive features and distinctive advantages of G-R Bentube Evaporators include their famous scale-shedding Bentube elements, design provisions for pure vapor, thorough drainage and easy accessibility.

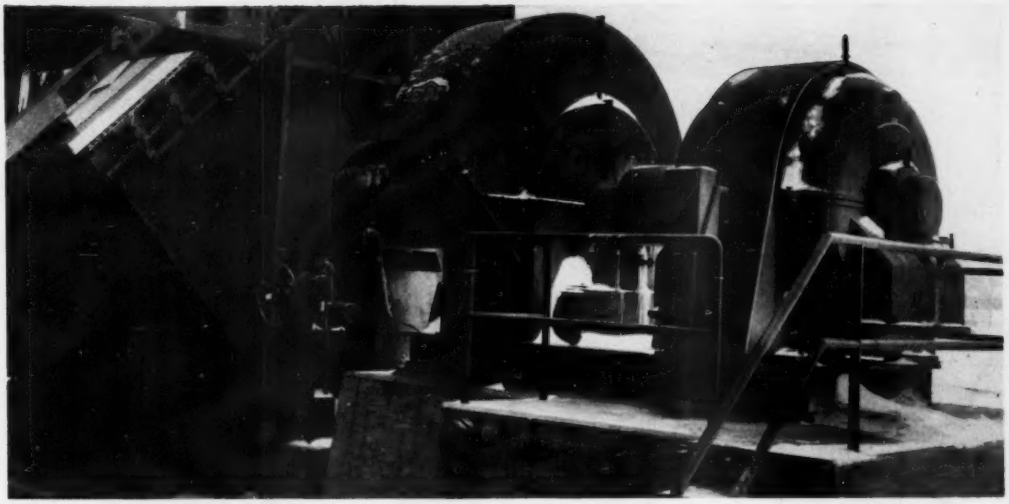
Write for Bulletin describing these units in detail.

THE GRISCOM-RUSSELL CO., 285 MADISON AVE., NEW YORK 17, N. Y.

GR-365

GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS



WHAT THE WELL DRESSED

magnetic drive

WEARS FOR OUTDOOR WORK...

Engineers inspect new Magnetic Amplifier Type E-M Regutron Control for Magnetic Drive installations similar to above. This new simplified control has no complicated electronic circuits to adjust . . . no tubes to wear out. A simple saturable core reactor amplifier system accomplishes the precise control of speed. Full information is given in Publication No. 1107 . . . sent on request.

● With building costs skyrocketing and inside floor space at a premium, a current trend in modern power plants is toward outdoor installation of equipment.

The E-M Magnetic Drive with outdoor enclosure, above, provides precise speed control for induced draft fans at The Dayton Power and Light Company, Dayton, Ohio. The Drive is dressed up in E-M's specially designed steel overcoat for weather protection. This welded steel plate enclosure has a rust resistant undercoating and is split in two sections for easy removal.

Ventilating air for the Magnetic Drive is taken in through a duct in the foundation and is discharged at the side of the enclosure . . . removable filters keep dirt and trash out. Volute contour of the enclosure is designed for proper, adequate ventilation.

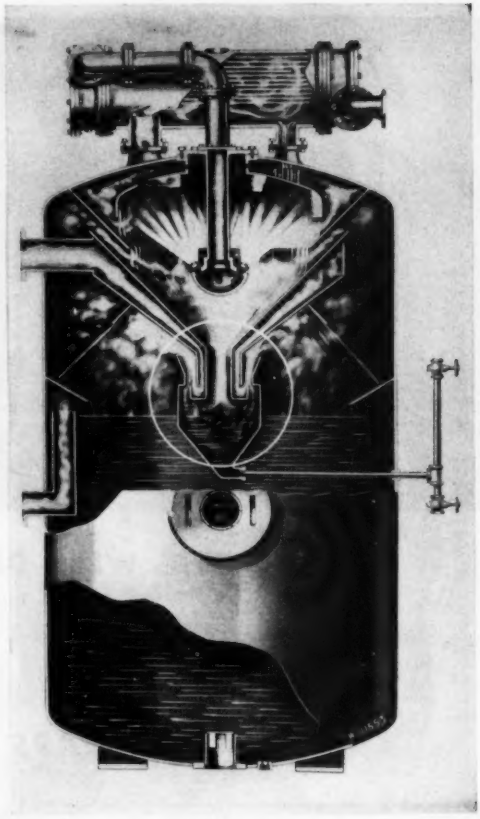
The E-M Magnetic Drive, an electro-magnetic torque transmitting device, is designed to provide variable speed control of driven machines from a constant speed a.c. motor. This adjustable speed plus a.c. economy is your best answer to efficient operation of boiler draft fans. And if you're planning your installation for outdoors, remember that E-M offers the effective protection described above.

Your nearest E-M sales engineer will be glad to advise or assist you in any stage of planning . . . call him or write the factory for Publication No. 1107.

E-M

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

4400-TPA-2103



Hard scale, formed on the trays of deaerating evaporator preheaters, is no longer the big problem it used to be.

In a large central station (name on request), the preheaters had to be cleaned every three weeks, and the units were completely shut down at that time from eight to ten hours.

Then Worthington steam-jet deaerators were installed—with a "blowdown" head designed by Worthington engineers. This special head allows the operator to remove harmful deposits at regular intervals *while the unit continues in service*. It also provides for simple and speedy acid cleaning of critical parts, when necessary, without even opening an access door or removing any parts from the unit.

Compare The "Time-Outs"

The Worthington unit, given a short blowdown once each shift, stays in continuous operation with maximum deaeration for periods of at least 8 months. When the acid treatment is given at the end of that period, the job is finished in under three hours.

Compare this with the former record. *Then*—8 to 10 hours outage every three weeks and labor by a *crew* of men. Now—with Worthington's blowdown head—operation uninterrupted during regular short blowdown, with a shutdown for acid cleaning only once in almost a year, requiring only one man and three hours!

Worthington Makes Deaerating Equipment News

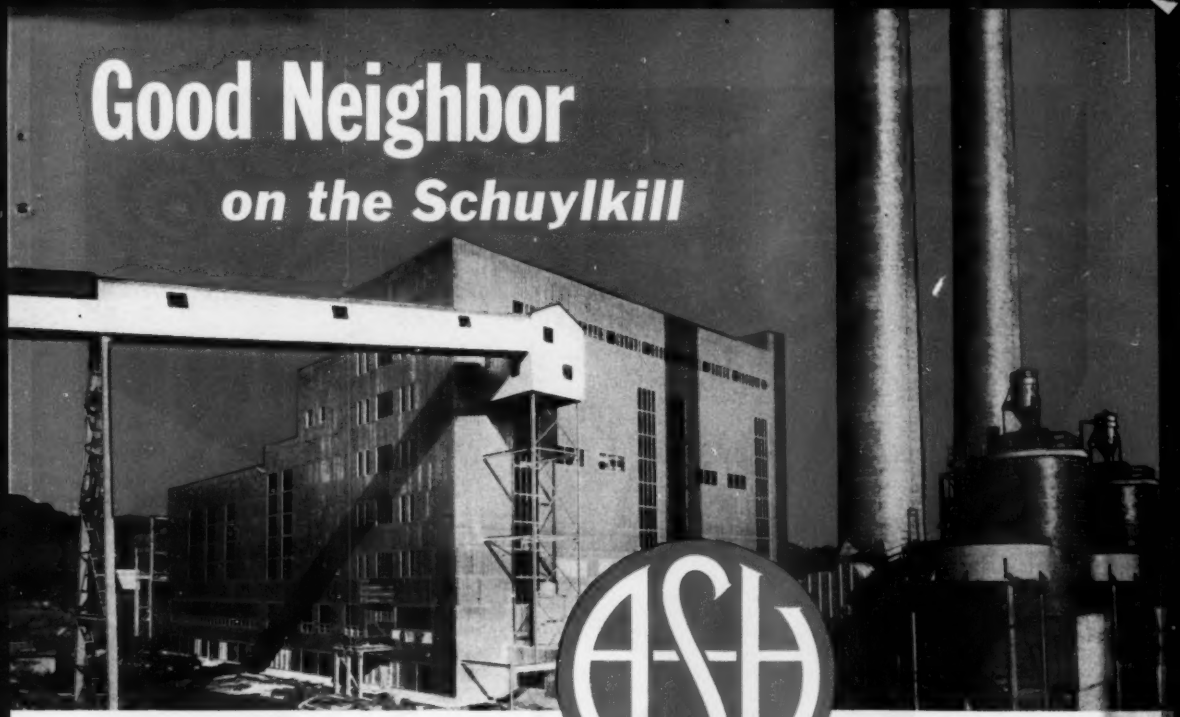
Developments like this, applicable to any deaerators operating under conditions of scaling, are typical of Worthington's engineering firsts in water treating and deaerating equipment.

Worthington manufactures all of the equipment needed in a complete water treating installation. For further information on why *there's more worth in Worthington*, address Worthington Pump and Machinery Corporation, Steam Power Div., Harrison, N.J.

WORTHINGTON

S.1.1

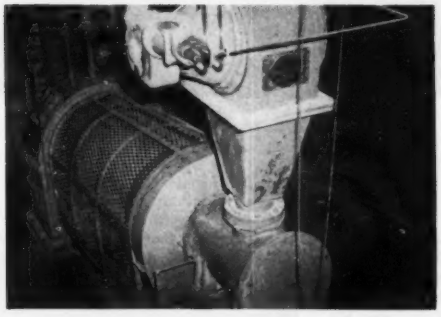
Good Neighbor
on the Schuylkill



A-S-H Hydro-Bins and storage silos beside stacks of Titus Station.

Metropolitan Edison's new $37,000,000 Titus Station, near Reading, Pa., was designed to be a good neighbor. Owing to modern water-treating methods, plus Hydrojet and Hydrovac, it returns purer water to the Schuylkill River than it takes out.

Pulverized bituminous coal is burned in the two 510,000-lb-per-hr steam generators now in operation. Ashes are collected in a flooded hopper under each furnace and are periodically Hydrojetted to a common ash sump which also receives the pyrites discharged from the coal pulverizers. The material is then pumped to either Hydro-Bin by means of ash pumps. After decanting, it is hauled to disposal areas by trucks.



A-S-H Dustless Unloader mixing fly ash with water so that it can be trucked to disposal points.

Fly ash is removed automatically from the soot hoppers by the Hydrovac System, and is discharged into either of two storage silos adjacent to the Hydro-Bins. Upon leaving the silos, the fly ash is moistened in A-S-H Dustless Unloaders so that it can be trucked without causing dust.

Hydrojet and Hydrovac Systems are designed by the men who have pioneered in modern ash and dust handling methods. You can put the fullest confidence in their recommendations for your plant.

THE ALLEN-SHERMAN-HOFF CO.

Dept. A—259 E. Lancaster Ave., Wynnewood, Pa.

Offices and Representatives in Principal Cities

HYDROJET (*hydraulic*) HYDROVAC (*pneumatic*)

materials handling systems

less servicing...more service

Steam power plants, using Monsanto Santosite to eliminate oxygen corrosion, are *spending less* time and money on servicing and *getting more* service out of their boilers.

Santosite (sodium sulfite anhydrous, technical) is safe, economical, easy to use. It takes *all* dissolved oxygen out of boiler feed water by combining with the oxygen to form harmless sodium sulfate. Neither Santosite nor sodium sulfate forms sludge or otherwise damages boilers or pipes.

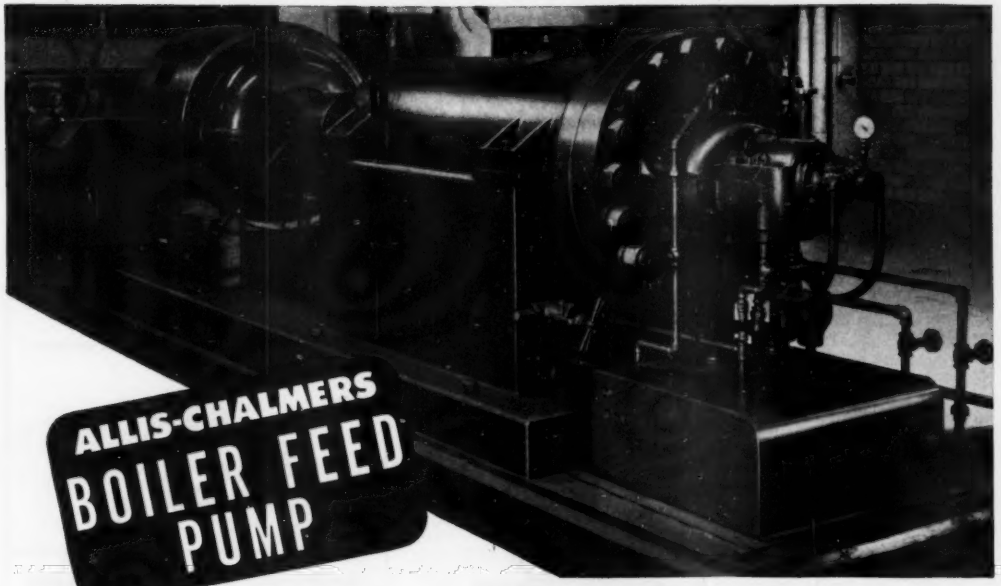
We suggest you get complete information on the use of Santosite to eliminate oxygen corrosion by writing for the Monsanto Technical Bulletin No. O-26, "*Santosite for Removing Oxygen from Boiler Feed Water*." MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1700 S. Second Street, St. Louis 4, Missouri.

DISTRICT SALES OFFICES: Birmingham, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle. In Canada, Monsanto (Canada) Ltd., Montreal.

Santosite Reg. U. S. Pat. Off.

MONSANTO
CHEMICALS AND PLASTICS

SERVING INDUSTRY...WHICH SERVES MANKIND



THESE 7 Features GIVE YOU RELIABILITY, LOW MAINTENANCE

1. Single stage, back-to-back impellers balance axial forces without use of balancing drum. Two impellers in first stage give advantages of double suction at this point.

2. Volute casing provides high efficiency and radial balance. Volute design also simplifies construction for easier maintenance.

3. Expansion joint is brought to outside of pump where leakage may be quickly detected and adjustments made without dismantling the pump. No flexible internal members are required for expansion compensation.

4. Packing is also located where it may be adjusted easily and quickly.

5. Uniform section of both inner and outer casings assures uniform expansion at all points. Expansion stresses are minimized; alignment is held.

6. Casing halves are held together with full hydraulic pressure of the pump assuring a tight seal with a minimum of heavy parts.

7. A carriage which may be attached to the pump body is furnished with each unit. The inner casing may be withdrawn from the outer casing on this carriage, making servicing easy and quick.

HERE IS A PUMP designed to meet the needs of the newer high pressure boiler plants. Efficiency is high, maintenance is low and every feature has a long record of successful application to boiler feed service.

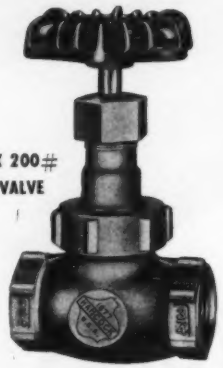
Sizes range from 1200 to 2500 psig and from 300 to 2000 gpm. Allis-Chalmers can supply the complete boiler feed pump installation including pump, motor and control of coordinated design and manufacture.

Get the details on this new boiler feed pump from your Allis-Chalmers District Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3407

ALLIS-CHALMERS

Introducing our new "baby"

THE HANCOCK 200# BRONZE VALVE
with "500 Brinell" Stainless Steel Seat and Disc



Globe and Angle Types, Screwed Ends
Sizes: ¼" thru 2"
Pressures up to 200#, 500°F.
Non-Shock Cold Water, Oil or Gas, 400#

Usual Bronze Valve Diaphragm Construction

Hancock Bronze Valve Diaphragm Construction
125% to 230% STRONGER

New in capacity . . . designed for durability . . . made with precision—here is the latest addition to the 74-year-old family of Hancock Valves. This new 200# valve gives you every premium design feature found in other Hancock Bronze Valves:

"500 Brinell" Stainless Steel Plug Seat and Disc. A Hancock "first." Nearly diamond hard—honed to mirror-like finish. No wire drawing, steam cutting, erosion or corrosion. Not affected by boiler scale, pipe turnings or other foreign matter. No leaks. Maintenance minimized.

125% to 230% Stronger Diaphragm Construction than ordinary bronze valves. Strains of installation and piping, expansions in piping systems can't harm it.

Hand-Rolled Bronze Stem. Tough, high tensile strength metal that can take the roughest treatment.

Real Back Seating for Packing Under Pressure. Direct seat between stem and bonnet—away from heat and flow of pressure media.

Long-Wearing, Tight-Sealing Packing. High-quality asbestos lubricated with graphite.

Cool, Comfortable Handwheel. Basket-type. Reinforced malleable iron. Built to operator specifications.

Before you specify bronze valves, check Hancocks against those of any other make. For greatest efficiency, longest service, biggest savings—*you'll choose Hancock.* Remember, they cost no more than ordinary valves.

Your nearby Hancock distributor will handle your valve needs promptly. Ask him about this new 200# bronze valve.

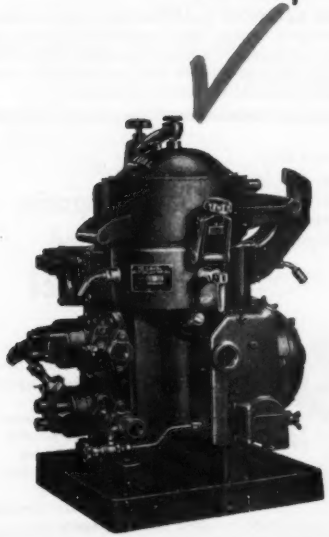
When Hancocks go in, valve costs go down

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** WATERTOWN 72, MASSACHUSETTS
MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' ELECTRICAL AND INDUSTRIAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

DOUBLE TROUBLE

BUT NOT YOURS!



Dirt and water will not ruin your lubricating oil if you use a De Laval centrifuge to purify the oil. For the De Laval machine will remove both the ***solid*** and the ***liquid*** impurities that so easily contaminate lubricating oil.

Centrifugal force, applied most effectively in the De Laval bowl, throws dirt out of the oil and stores it out of harm's way until cleaning time. The dirt that has been removed cannot re-mix with the oil and contaminate it all over again, nor can dirt store up within the purification area to lessen the ***effective*** centrifugal force. As far as water is concerned, once it is centrifuged out, it is gone — discharged to waste.

That is why De Laval Oil Purifiers are ***constant efficiency*** units—purification as sure at the end of a run as at the beginning. De Laval Protection is Double — and unvarying from first to last.

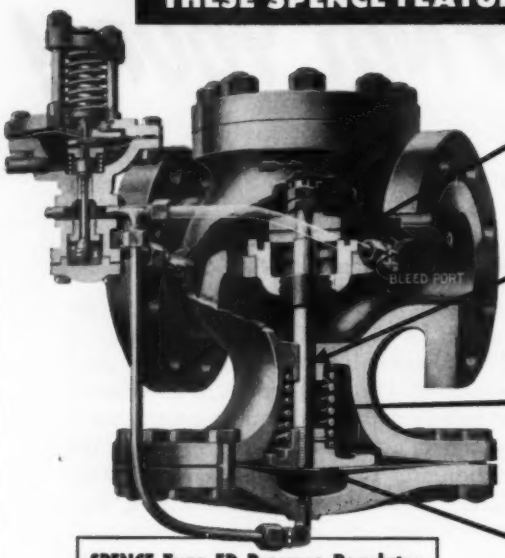
THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL LUBRICATING OIL PURIFIERS

HERE'S PROOF

You Can Cut Costs of Pressure and Temperature Control

THESE SPENCE FEATURES SHOW YOU HOW



SPENCE Type ED Pressure Regulator

SECO METAL SEATS AND DISCS — Durable SECO Metal resists wiredrawing. *More than twenty years of experience in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.*

PACKLESS CONSTRUCTION — All Spence main valves and most pilots are built without stuffing boxes. This minimizes friction . . . eliminates much time-consuming maintenance.

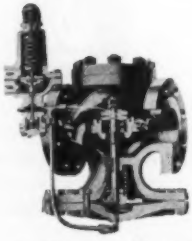
SPRING OUT OF PATH OF STEAM — The spring in the Spence Regulator is out of the path of the steam or other fluid flowing through the valve. It operates at low unit stress for exceptionally long life.

LARGE BALANCED DIAPHRAGM—Spence metal diaphragms, under usual conditions, never require replacement. Spence Regulators have few moving parts and those few are ruggedly constructed and seldom require attention.

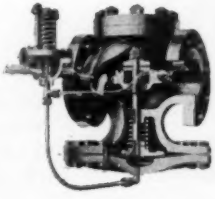
YOU BENEFIT by these and many other Spence features that assure *accurate, dependable* regulation year after year. That means *less down-time, less time and money wasted on replacement of parts.*

Spence Pressure and Temperature Regulators are built in sizes from *¼" to 12"* for service with *air, steam, water, oil or gas.* Only minor adjustments are needed to switch any Spence Regulator from one service to another.

Type ET1SO Temperature Regulator—Tops in performance for both storage and instantaneous heaters.



Type EN Differential Regulator—Accurately controls differential between fluid delivered by regulator and some other source of pressure connected to the pilot spring chamber.



Type EQ Back Pressure Regulator — Completely packless, pilot operated for accurate control of the initial pressure.

These Companies Have Profited with SPENCE!

The Springs Cotton Mills
Ford Motor Company
Pennsylvania Power & Light Company
Jones & Laughlin Steel Corporation
National Tube Company
The Atlantic Refining Company
Great Lakes Steel Corporation
Todd Shipyards Corporation
Land O'Lakes Creameries, Inc.
General Electric Company
R. J. Reynolds Tobacco Company
Ohio Edison Company

and thousands of others

SPENCE ENGINEERING COMPANY INC.
WALDEN, NEW YORK

Spence

NEW!

EAGLE-PICHER
one-cote all-purpose cement!

check these advantages!

- *Combination* insulating and finishing material for temperatures to 1000 F.
- Just one coat
- Quick setting
- Light color, smooth surface
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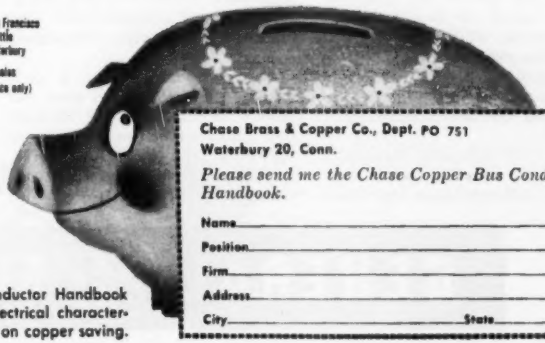

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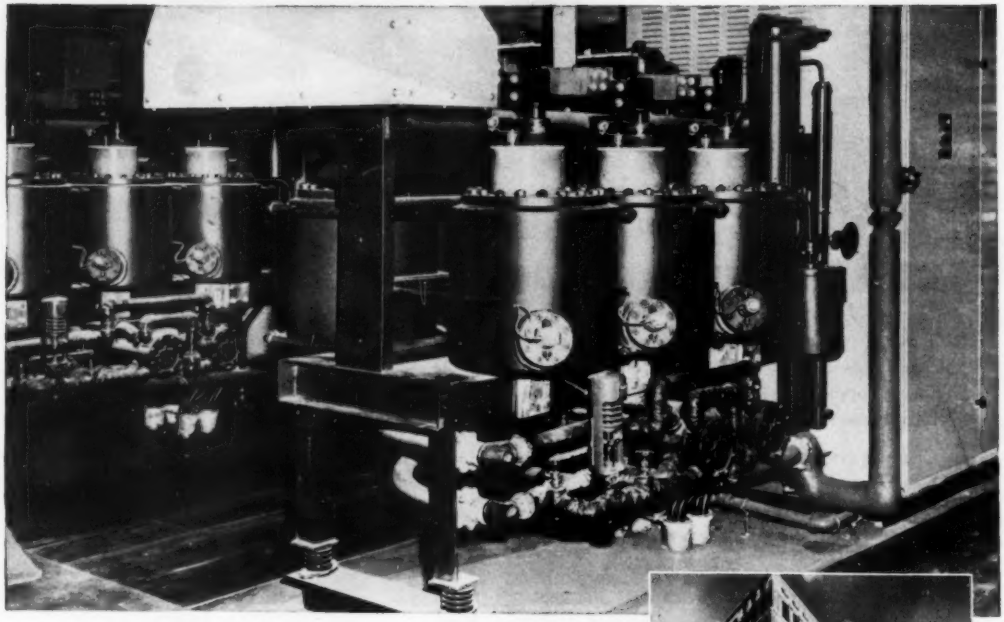

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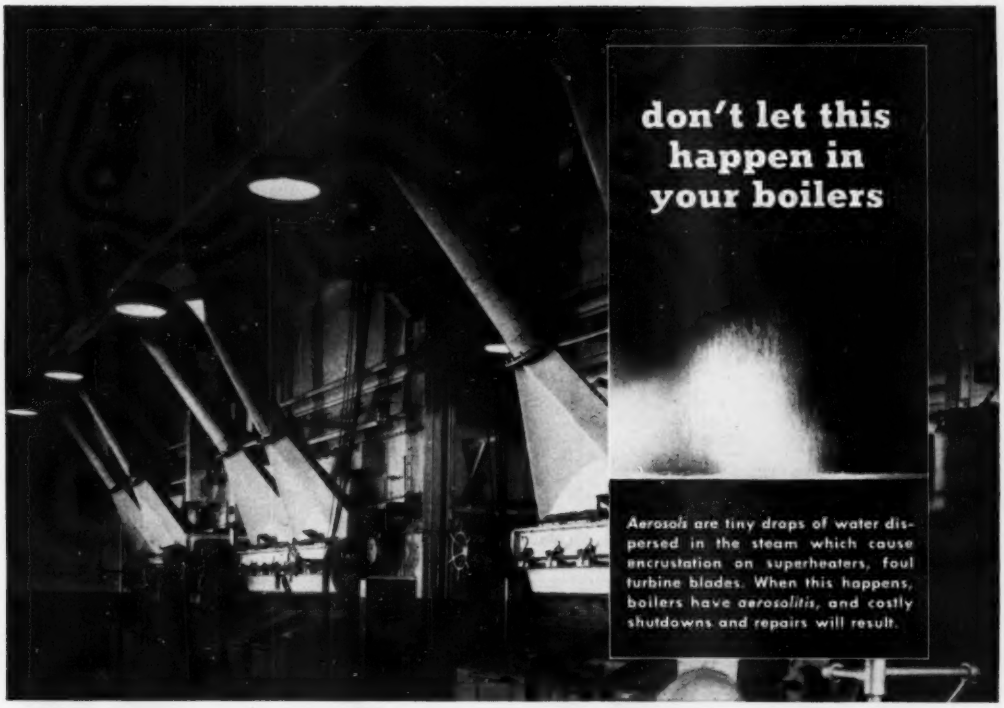
For information on a G-E Ignitron Rectifier to fit your d-c power needs, ask your nearest G-E Sales office for a copy of bulletins GEA-5539 and GEA-5569 or write General Electric Company, Schenectady 5, N.Y.

Major portion of the power load of this huge store is supplied by the 5000 kw G-E Ignitron Rectifier installation.

324-3

GENERAL ELECTRIC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Aerosols are tiny drops of water dispersed in the steam which cause encrustation on superheaters, foul turbine blades. When this happens, boilers have aerosolitis, and costly shutdowns and repairs will result.

prevent aerosolitis

with Dearborn improved polyamide anti-foams

Your healthy looking steam boilers may be suffering from *aerosolitis* . . . the expensive boiler disease.

But *aerosolitis,* more prevalent with some waters than with others, is easy to cure with Dearborn Improved Polyamide Anti-Foams. In addition to inhibiting aerosol formation, Dearborn Improved Polyamide Anti-Foams prevent foaming to produce purer steam . . . eliminate scale formation . . . condition sludge . . . are compatible with other treatment.

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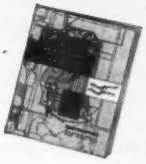

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Power
COMBINED WITH OPERATING ENGINEER

The Long Look Ahead

AT THIS WRITING the Korean scene looks a little brighter. By the time you read this page our hopes may be higher or lower. We *Power* editors can't predict which, but we're sure that no possible turn in the Korean war can erase the challenge that faces every power engineer.

Russia was the great threat before Korea exploded in our faces—and will keep on threatening, *regardless of peace or war in the Far East.*

With her left hand, so to speak, America is fighting a terrible, but localized, war with Chinese communists on a peninsula near Japan. With her right hand she is building war potential to meet the world-wide threat of Russian domination.

As we see it, there are two great dangers in the situation. One is that Russia might precipitate a world war in 1951 or 1952 while we are still woefully unprepared. We don't expect this to happen, but can't be sure. The second danger is that our national will to arm may be softened up by some easing of the fighting in the Far East. This, too, we think won't happen, but it's a danger to guard against.

In our opinion the following facts will be plain to every engineer willing to face the evidence:

1. Russia is, and will be for years, the deadly enemy of the whole free world, and particularly of the United States. We block the path of her expansion.

2. Russia's word will still be worthless, as it has been all along.

3. For many years nothing but superior military and industrial might will protect the free world from Russian communistic imperialism.

4. America and her allies are still far too weak for comfort or safety.

5. So we must keep on arming at top speed despite the terrible cost in waste, taxes and inflation.

6. If we do this, we may hope to reach a reasonably safe level of defense strength by 1953.

7. Meanwhile we should keep the civilian economy rolling on a restricted basis and try to keep some control over inflation.

8. By 1953, if we have still escaped World War 3, the chances of later war will be reduced, but we shall be forced to maintain armed strength for many more years. American productive genius can accomplish this while maintaining living standards equal to 1950, or better.

If you, as power engineers, accept these conclusions you will gird your own plant to meet the following challenges during the next two years: increasing demand for your power services, continued insistence upon service reliability and quality, rising costs and wages, manpower shortages, possible loss of key men, shortages of steel, copper and certain other materials, possible difficulty of obtaining certain essential spare parts, occasional fuel shortages, plus governmental controls with their red tape and paper work.

To clear these hurdles you will step up your preventive maintenance, stock essential spare parts, train your men to handle other jobs in a pinch and stock fuel as far as practicable. You will also plan ways to keep production rolling if a vital power-service unit should break down, or if demands for steam, electricity, water and compressed air should rise rapidly, or your usual fuel be cut off.

It Gives You the Torque

Edward Valve IMPACTOR HANDWHEELS

GIVE YOU FROM 2.8 TO OVER 12 TIMES THE FORCE OF AN ORDINARY HANDWHEEL TO CLOSE VALVES

It takes three strong men, pulling their hardest, on an ordinary valve handwheel to equal the closing force of ONE man using an Edward 16" Impactor Handwheel. With progressively larger size Edward Impactor Handwheels, the force available to close a valve is equal to six, eight, ten and, yes, *even twelve men.*

Originated and patented by Edward and improved through the years, the Impactor handwheel is the one most effective means of manually closing a valve so it is absolutely tight against high operating or test pressures in power, petroleum, chemical, marine, or industrial plants. It needs no clumsy expensive gear or toggle construction, or the use of extension levers or cinch bars for actuating.

Its space-saving design allows piping designers great latitude in locating valves, walkways and operating platforms.

But most important, the Edward Impactor handwheel means sure, fast operation of valves—big or little—in an emergency or under normal operating conditions by a single man. It saves manpower by giving ONE man more power. NOW standard equipment on most 900, 1500 and 2500 lb Edward Valves, 2½ inches and up.

The Impactor principle is simple. Two heavy lugs are cast on the underside of the wheel: a sharp turn of the wheel causes these lugs to strike simultaneous blows against a steel cross arm, locked to the stem or revolving EValthrust yoke bushing. Write for full facts, Edward Valves, Inc. 1220 West 145th Street, East Chicago, Indiana.

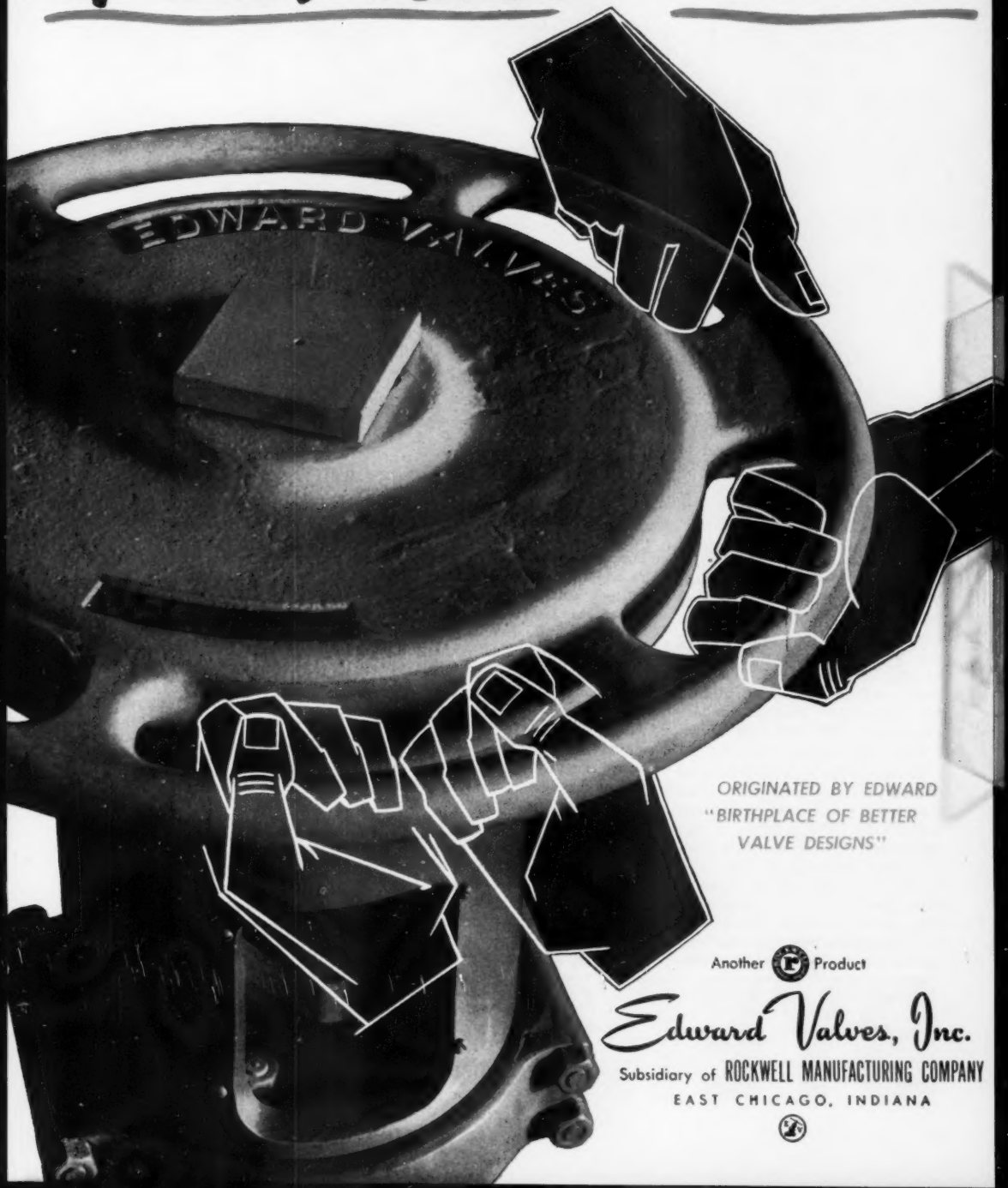
WOMANPOWER BEATS MANPOWER!

Many smaller size Edward valves are available with the new Impactor Handle (right in photo) for greatest closing efficiency. Design principle is same as Impactor handwheel, and test gages prove it too gives you the torque of six hands or 2.8 times the closing force of an ordinary handwheel. You know the valve is closed absolutely tight with an Edward Impactor Handle.

FEATURES LIKE THIS SAVE YOU MONEY AND WORK . . . .

That's why it pays to specify Edward Valves.

# of SIX Hands and More



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Another Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

This hospital power plant cures pipe ills with *BYERS WROUGHT IRON*

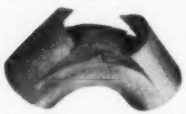
Engineers—DeLeuw Cather & Co.—Chicago

Since water is the life-blood of every power plant, an unfailing supply is of first importance. In the plant at the Kankakee (Illinois) State Hospital, the job of safeguarding this service was entrusted to genuine wrought iron. Over thirty tons of Byers Galvanized Wrought Iron pipe, in sizes from $1\frac{1}{2}$ to 8-inches, was installed in the supply system, and in extending the water distribution system in certain adjacent areas. The material was already being utilized for maintenance work on condensate return lines in the steam distribution system.

Power plants in all sections of the country are using this same time-tried method of protecting water lines. The wisdom of the choice is confirmed by many comparative records of genuine wrought iron still serving in water lines after thirty—forty—and even fifty years, in areas where low-first-cost piping materials required repairs and replacement in a fraction of the time. The condensate return application is another that follows established engineering precedent. Condensate is always aggressive, and genuine wrought iron has proved itself remarkably successful in resisting attack.

It is helpful, in applying genuine wrought iron in the many places where it can reduce repairs and maintenance, to know something of how it is made, how it resists corrosion, and where it has been used. All this is digested in the booklet, THE ABC's OF WROUGHT IRON. May we send you a copy?

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. Export Division: New York, N. Y.



WHY WROUGHT IRON LASTS

This notch-fracture test specimen illustrates the unusual fibrous structure of genuine wrought iron—which is responsible for the unusual corrosion resistance of the material. Tiny threads of glass-like silicate slag, distributed through the body of high-purity iron, halt and disperse corrosive attack, and discourage pitting and penetration. They also anchor the initial protective scale, which shields the underlying metal.

BYERS

CORROSION COSTS YOU MORE THAN WROUGHT IRON

WROUGHT IRON

TUBULAR AND HOT ROLLED PRODUCTS

ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS

Power
JULY 1951

LESS THAN 30 DAYS' REFUSE removed by a utility's coal breaker. This is one example of how . . .

Crushers Cinch Fuel Sizing, Cleaning

Fourteen questions and answers help you pin down what crushers do, how they work, types available for your job. This is the first of two articles

By TYLER HICKS. *Assistant Editor*

1 What is a coal crusher?

A device to reduce coal lumps to suitable size for stoker or pulverizer. It is especially useful with run-of-mine coal, sized coal that is frozen or lumpy, and coal containing foreign matter. Some crushers remove foreign matter while reducing lump size.

2 What types of crushers are used most often in power plants?

Single-roll, Fig. 2, and double-roll crushers, Fig. 3, 7 and 8, hammer mills, Fig. 4 and 5, and Bradford breakers, Fig. 1, find much use in power plants today. Three- and four-roll crushers find some use, too. Each crusher design has certain advantages that make it suitable for a particular job.

3 How do single-roll crushers work?

As shown in Fig. 2, the toothed roll crushes coal against the breaker plate. Coal lumps are reduced to desired size and discharged from the lower part of the roll. Product fineness is adjusted by shifting the breaker plate with respect to the roll. Spiral relief springs on adjustable breaker-plate rods protect roll from damage by foreign matter. Plate swings away from roll when particles harder than coal are caught between the two. Or a shear pin is used on driving pulley. This breaks when hard materials resist roll turning. V-belt drive is often found on single-roll units.

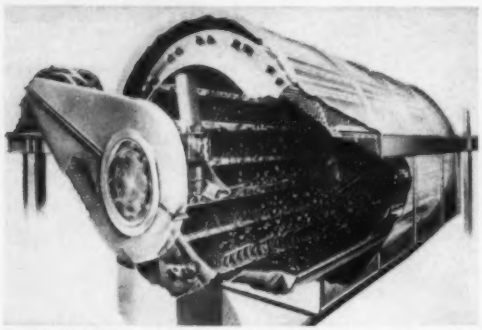
4 How do double-roll crushers work?

Two rolls, both toothed, revolve and crush the coal between them, Fig. 3, 7 and 8. Relief springs and floating bearing permit one roll to yield so hard materials can be passed. Modern designs permit size adjustment during operation. V-belt drive is often used.

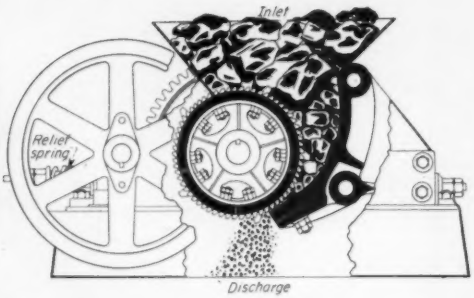
5 How do hammer mills operate?

Called hammer mills or ring crushers,

MANY TYPES OF COAL CRUSHERS ARE AVAILABLE FOR VARIOUS POWER-PLANT JOBS

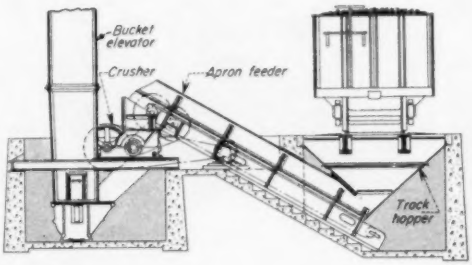


1 **BRADFORD** breaker lifts and drops coal for gravity-impact breakage. Tramp iron and refuse automatically discharged



2 **SINGLE-ROLL** spring-relief coal crusher can be used for sizing coal fed to pulverizers, stokers and other units

5 **DOUBLE-ROTOR** hammer mill splits coal on initial impact, then crushes it on breaker plates. Each rotor has motor



6 **APRON FEEDER** delivers coal from track hopper to the coal crusher. With coal in hopper, feed to crusher is constant

these units, Fig. 4 and 5, have one or more high-speed rotors fitted with pivoted hammers. These hammers crush, grind and shatter lumps through a semi-circular grid, spanning the discharge opening. Spacing of grid bars determines maximum product size. Hammers may be circular, triangular, serrated circular for "shredding," tooth or bar shaped. Grinding plate, similar to breaker plate, is usually adjustable for varying fineness. In many types grid is also adjustable. Foreign matter too hard to crush is thrown by centrifugal action into a trap. Hammer mills are used where fine crushing is desired. Some hammer mills are reversible, permitting symmetrical sharpening of hammers, avoiding shutdowns for "turning hammers" and helping maintain best crushing surface.

6 How do Bradford breakers crush coal for power-plant use?

Coal is continuously charged at the loading end. Passing sizes are immediately screened out through perforated plates. Larger lumps are raised by radial lifting shelves, Fig. 1, and dropped. Gravity impact breaks the coal as it falls on the heavy perforated screen plates. Units are chain driven and turn at slow speed (12 to 18 rpm). Debris that can't pass screen openings travels the full length of the breaker and is automatically discharged along with tramp iron, timber and other refuse. Some large-capacity breakers have a modified hammer mill fitted inside the main cylinder. This substantially increases capacity and breaks lumps that might not crack by tumbling alone. Bradford breakers reduce coal to needed size with fewer fines than other crushers.

7 What foreign matter may be in coal?

Debris and refuse found in coal vary with coal source and other factors. But sulfur balls, slate, bony, rock, tramp iron, timber, nonmagnetic metal lumps; rags and straw are some of the materials you may find in coal fed to crushers. They must be removed or reduced to unharmful size.

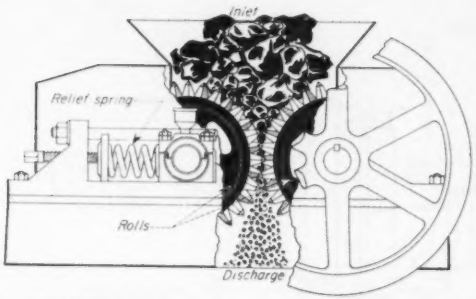
8 How does fineness of product vary with different types of crushers?

Single-roll crushers produce anything from 1¼- to 1½-in. lumps. With two rolls, lumps can be reduced to 1¼ in.; when fitted with small teeth or flutes on the rolls, ½-in. lumps can be obtained. But there is considerable loss of gripping power of the rolls. Final size depends somewhat on crusher design. For finer products hammer mills may be used. Depending on spacing of grid bars, or screen-opening size, and hammer type, size varies from 1¼- to ⅜-in. lumps. Bradford breakers without hammers produce ¾- to 1¼-in. lumps, depending on the size of the screen used.

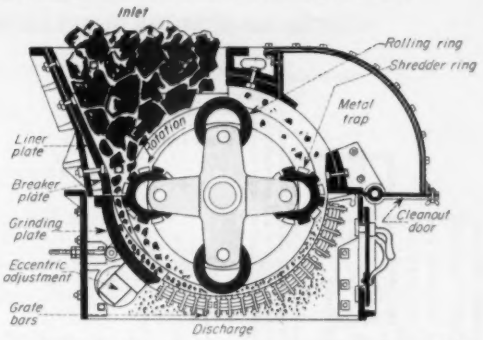
9 Are all coals of same hardness?

No. Some coals are extremely hard; others are medium hard; some are relatively soft. Among hard coals are West Virginia splint, Indiana block, Illinois, Iowa, Colorado, Wyoming, Pennsylvania Freeport, Kittanning and cannel. Hardgrove grindability ranges through 45 to 60. A few medium-hard coals are W. Va., Thacker, Panther, Banner, Coalburg, Kentucky, Harlan, Hazard No. 4, No. 7 Block and Ohio Hocking. Hardgrove grindability ranges through

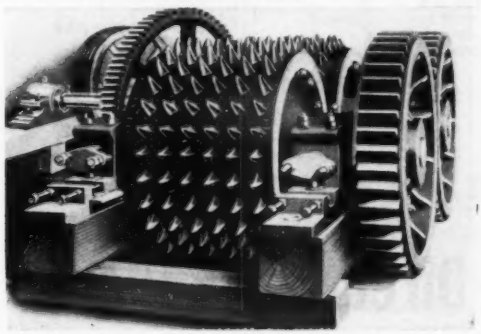
USE COAL CRUSHERS FOR MORE UNIFORM FEED SIZES TO STOKERS AND PULVERIZERS



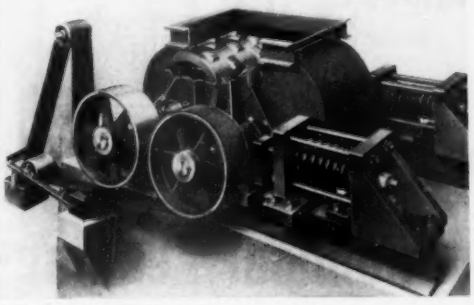
3 **TWO-ROLL** crushers have belt, gear, chain drive, depending on conditions. Coal crushed between two toothed rolls



4 **HAMMER MILL,** or ring crusher, is good for fine crushing. Rings shatter and grind lumps through the discharge grid



7 **TWO-ROLL** gear-driven crusher has plain circular manganese segments fitted with "hawk-bill" teeth. Gear is sectional



8 **ROLLCRUSHER** fitted with "slugger" teeth on both rolls. Solid or renewable slugger shells are used in this unit

60 to 80. Some soft coals you might want to crush are Pocahontas, New River, Connellsville, Pittsburgh No. 7 and 8, and Youghiogheny. Hardgrove grindability ranges through 80 to 105.

10 How do crushers improve moisture distribution in a coal?

Wet coal fed a crusher has most of the water in surface-moisture form. The finer a coal, the more moisture it can carry. Crushing exposes new dry surfaces to which moisture spreads. So a more even distribution of moisture is secured. When dry lumps are mixed with wet fines, serious size and moisture segregation may occur in bunkers. Fine crushing can reduce it considerably.

11 How do crushers reduce ashpit losses in stoker-fired boilers?

Large coal lumps supplied to a grate ignite slowly and, for a given stoker speed on traveling grates, will drop into ashpit high in carbon. Finely sized coal that stays on the grate burns out more completely, reducing ashpit losses. Coal that is too fine falls through grates or burns out in spots, allowing excessive quantities of air to pass through. In moderate-size industrial plants operating efficiencies have been increased 2.5 to 8% by proper sizing before feeding to stoker. In larger plants efficiencies have been raised 3% by crushers that reduce ashpit and excess-air losses.

12 Can crushers control rate at which coal is fed them?

No, they cannot. So unless a conveyor fixes feed rate a feeder of some sort is needed. Continuous feeding is best for crushers because they perform better under these conditions.

13 What types of feeders are used?

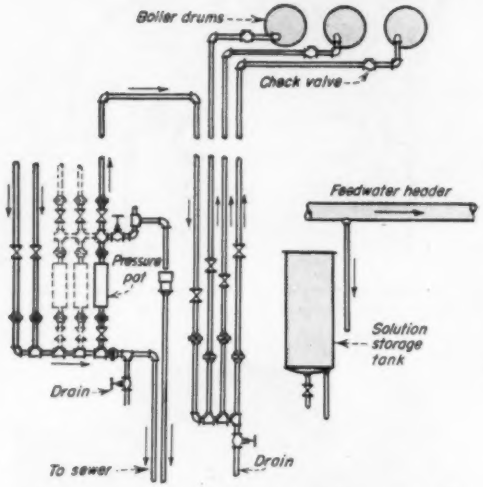
Conveyors, reciprocating, apron, mechanical and electromagnetic vibrating feeders can be used for crushers. Single reciprocating feeders give pulsating flow; hence twin units that discharge alternately are better because a more even flow is obtained. Apron feeders are good, giving more continuous flow and distributing lumps in the moving stream of coal. Mechanical and electromagnetic feeders screen fines ahead of crusher, have easily adjusted feed rate. Regardless of feeder type used, it must stop promptly if crusher stops.

14 How can plants using sized coal profit by installing a crusher?

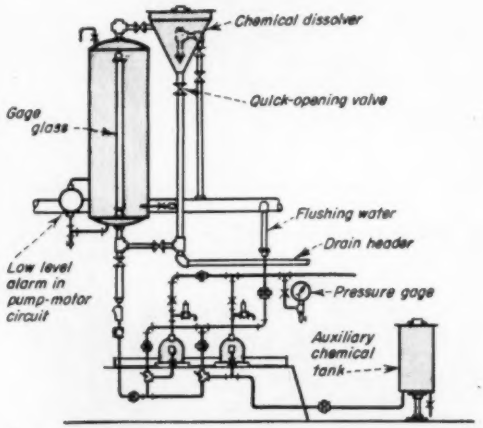
When run-of-mine coal is available it can be economically purchased and crushed if it falls below a price that makes this procedure profitable. So a standby crusher can pay off in some plants. When sized-coal price falls, or run-of-mine rises, crusher can be bypassed and sized coal burned.

POWER *is indebted to the following manufacturers for information and assistance: American Pulverizer Co, C O Bartlett & Snow Co, Buffalo Hammer Mill Corp, Condenser Service & Engrg Co, Fairfield Engrg Co, T J Gundlach Machine Co, Gruendler Crusher & Pulverizer Co, Hewitt-Robins Inc, Heyl & Patterson Inc, Jeffrey Mfg Co, Kennedy-Van Saun Mfg & Engrg Corp, Link-Belt Co, Marion Machine Foundry & Supply Co, Pennsylvania Crusher Co, Stephens-Adamson Mfg Co, Sturtevant Mill Co, Williams Patent Crusher & Pulverizer Co, Wilmot Engrg Co.*

CHEMICALS BEING FED DIRECT TO BOILER DRUMS RUN FROM ACIDS TO ALKALIES . . .



1 Slug feeding of chemicals to the high-pressure boilers requires a vessel heavy enough to withstand the pressure



2 Continuous-feed systems deliver supply through feed pumps connected to closed chemical solution tanks, *above, right*

Chemical Feeding—Direct to Boilers

By **SHEPPARD T POWELL**, *Chemical Engineer*

► BOILER-WATER TREATMENT is a complex problem requiring top skill. The range of chemicals available and the problems they treat vary widely—so much so that an expert has to work out the individual feed as well as equipment to get it into the boiler cycle.

In general the equipment for chemical feeding divides into two main classes: (1) low-pressure low-temperature apparatus for applying the chemicals in the preboiler system[1] (2) more complex designs for direct feed to high-pressure high-temperature boiler cycle.

This latter class, direct-feed, characterizes most internal boiler water-treatment systems. While there are many individual chemicals handled, there are relatively few distinct feeder methods. The most important are described below.

Solution Displacement. The more or less familiar "pot" feeder of the preboiler cycle[1] with some changes can serve for high-pressure direct-feed duty, Fig. 1. First off, a pressure vessel heavy enough to withstand full boiler pressure must be used. It is charged with a chemical solution while it is still cut out of the boiler circuit. Then the feedwater is cut in at full pressure to sweep out the chemical solution and discharge it into the high-pressure feedwater inlet header or direct to the drum.

You can use manual or automatic control to cut the chemical feeder into the cycle at desired intervals. When automatic control does the job, motor-operated or solenoid valves carry the burden. They may respond to settings of the feedwater or steam flowmeters to inject the chemical in proportion to the total water entering the boiler.

Pumping Equipment. If you want to feed chemicals continuously, as you will for phosphate, sulfites, caustic, for instance, you'll need some pump arrangement. Fig. 2 and 4 are good examples for phosphate feeding. Fig. 2 applies for normal phosphate needs and Fig. 4 for requirements that run high.

Both assemblies employ a closed tank and dissolver, similar to those you'd use with caustic or sulfite. In Fig. 2, two high-pressure pumps, one a spare, feed directly to the boiler drums. One set of pumps and discharge header can serve a number of boilers when feeding is needed only once or twice a shift. This rate of feeding holds where make-up stays low and is completely softened.

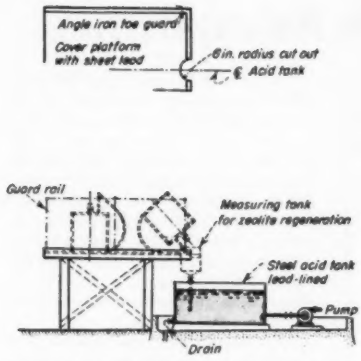
In addition, Fig. 2 has an auxiliary chemical tank connecting to the pump suction. With it you can conveniently dose idle boilers or inject miscellaneous chemical treatments.

Fig. 4 is the kind of feeder you find most often where phosphate requirements run high. A hinged top permits easy addition of chemicals, while a motor-driven mixer keeps solution agitated for quicker dissolving.

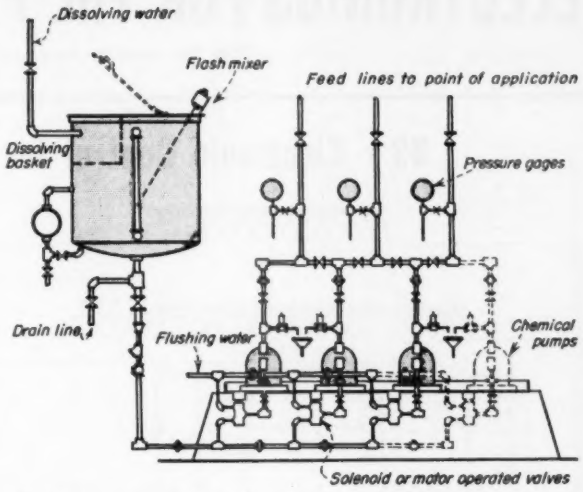
Continuous Circulating Feed. One rather special adaptation of the continuous pumping system above is a special high-pressure chemical header. This header, run near all boilers, allows a separate feed to each boiler through a calibrated V-port or needle valve. The high-pressure header carries a release valve to discharge solution back to the chemical mixing tank if throttling is too much. Once boiler-water phosphate tests are made, the individual boiler feed valves are reset, according to the deficiencies, to bring up each boiler to the desired level.

[1] "Proper Chemical Feeding Gets Results," S T Powell *Power*, June 1951.

. . . REQUIRE EQUIPMENT TO WITHSTAND PRESSURE, OPERATE SAFELY UNDER CONTROL



3 Acid-feeding to boilers calls for special precautions in handling, storage and actual feeding



4 High, continuous phosphate feed to boiler drums requires changes in feed rate by mechanically operated valves to reflect water variations

Depending on the results you want and the chemicals you handle, there's equipment that will deliver them gradually, in slugs, or to predetermined cycles. Here's an experience roundup by an expert on what to use, where

Automatic Feeding. With high, continuous phosphate feeding, say for a large quantity of lime-soda-softened makeup water, feed changes should be scheduled at short intervals. If possible, have changes reflect variations in hard-water consumption.

One system uses a separate phosphate pump for each boiler with one extra as a spare. A motor- or solenoid-operated 3-way valve at each phosphate pump suction alternately supplies phosphate solution, then flushing water (condensate) to the pump section. A timer system under control of a flow meter or program clock determines the time of feed cycle, that is, how long the phosphate solution flows to the pump, and how long the flushing water.

One timer keeps the phosphate pump operating for its predetermined time, say, 20 minutes. A second timer energizes the 3-way valve at the beginning of the cycle to turn it to the phosphate-feeding position. A third timer, which allows adjusting dosage in proportion to hard-water consumption, changes the 3-way valve back to the flushing-water position after maybe eight minutes. During the balance of the cycle this flushing water is pumped through the piping to push all phosphate solution into the boiler. Then the entire system goes out of service until the next cycle.

Acid Handling. Acid for boiler feedwater treatment and auxiliary water conditioning has been growing in importance for power-plant service. It can do several jobs: (1) reduce alkalinity (2) regenerate acid zeolites (3) maintain sulfate-carbonate ratios (4) release CO_2 from carbonates and bicarbonates.

Several acids, including sulfuric, sulfurous, phosphoric, hydrochloric and carbonic are used rather extensively. Lactic and nitric acids as well as some others have less widespread application.

The preferred way of handling and storing these acids depends on their quantity. If only a little acid is needed, order it in carboys and store it that way. Equip the storage place with fountain showers so in case of accident those handling the acids can wash themselves quickly.

If you use enough acid to justify bulk purchases, have the acid unloaded directly from tank cars. Then handle the acid in accordance with the directions of the Manufacturing Chemists Assn's manual of standard and recommended practice.[2] Further, the organization will supply you with bulletins relating to this problem.

Several schemes work in handling acids:

1. If acid is to be received by tank-car shipment, transfer it to a storage tank near the spot you plan to use it. Transfer of either hydrochloric or sulfuric acid from tank cars to storage should be made in accordance with safety rules recommended by the Manufacturing Chemists' Association or other recognized authority. Design the storage facilities to provide all necessary safeguards to work and equipment. A typical arrangement of satisfactory acid-storage facilities shows in Fig. 3.

2. When acid arrives in carboys, use only approved means for handling and transferring acid.

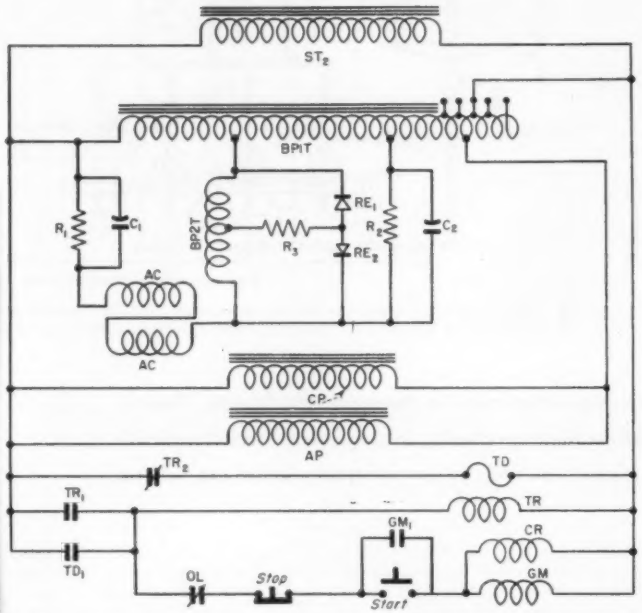
3. When the acid is pumped from a carboy to a dilution tank, arrange equipment for this operation with safety in mind.

[2]Manufacturing Chemists Assn, 246 Woodward Bldg, Washington 5, D. C.

ELECTRONICS FOR THE POWER ENGINEER

By F A ANNETT, *Associate Editor*

39 — Electronic Control for Dc Motors: II



1 Connection network for phase-shifting the grid voltage of the motor-armature power tubes T_6 and T_7, Fig. 2, to control motor's speed from potentiometer P_1

► THERE ARE THREE COMMON WAYS of adjusting the speed of shunt dc motors: (1) varying armature voltage while holding field voltage practically constant (2) changing field-coil voltage when armature voltage is held nearly constant (3) combining both methods. Electronic-control systems are available that power dc motors from an ac supply, and control their speed by any one of the three methods outlined. Here we will study an electronic system for operating dc motors from an ac system that adjusts speed by armature-voltage control.

Control Features. Fig. 1 and 2 diagram a General Electric electronic motor control that in addition to controlling the speed of a dc motor includes several other features. Besides the usual overload protection, armature current is limited to a preset value during acceleration, such as 150% of rated. Also, means are provided for holding speed practically constant at a preset value even though the load may change. Other features not shown in the diagram are dynamic braking for quick stopping and regenerative braking for use on reversing drives.

Control Transformers. The diagram looks a little complicated, but it is quite simple if we study each feature separately. The single-phase ac power supply connects to the anode power and control transformers. Secondaries ST_1, Fig. 2, and ST_2, Fig. 1, are part of the anode power transformer, the primary of which is not shown.

Primary *BP1T*, Fig. 1, powers the phase-shifting network consisting of resistors R_1 and R_2, ac coils *AC* of a saturable reactor and primary *BP2T* for *BS2T* secondaries, connected to the grids of the motor-armature power tubes T_6 and T_7 Fig. 2. Primary *BP1T* also energizes the secondaries that heat the cathodes of the armature power tubes.

Primary *CP*, Fig. 1, energizes secondaries *CT* that heat the motor field power tubes T_8 and T_9. Also, primary *AP* is part of the transformer that heats the cathodes of the control tubes, Fig. 2. Secondaries on these have been omitted to simplify the diagram.

Time Relay. When the line switch is closed the power transformer is energized to make secondaries ST_1 and ST_2 alive. Armature power tubes T_6 and T_7 and field tubes T_8 and T_9 cannot conduct until contacts GM_2 and TR_3 close, Fig. 2. Closing these contacts is controlled by timing relay *TD*, Fig. 1, to give the power tube cathodes time to heat before being loaded.

This relay is energized from secondary ST_2 when the line switch is closed and starts timing out. In about 5 min, contact TD_1 closes to complete a circuit through relay coil *TR*. Energizing this coil closes contact TR_1 to form a holding circuit around TD_1 and to open contact TR_2 to disconnect the timing relay. Relay coil *TR* also closes contact TR_3 in the field-coil circuit and opens TR_4 to break the field-coil discharge circuit.

Shunt-Field Circuit. The field coils are now excited from center tap *T* on secondary ST_1 through resistor R_{25}, the field coils contact TR_3, either tube T_8 or T_9, back to ST_1 depending on the secondary's polarity. Adjustable resistor R_{25} is used to obtain correct voltage across the field coils.

With these coils excited, everything is in condition to apply voltage to the armature. This is done by pressing the start button, Fig. 1, which energizes coils *CR* and *GM*. Coil *CR* opens contacts CR_1 and CR_2. Coil *GM* closes contacts GM_1 and GM_2. Contact GM_1 forms a holding circuit around the start button so it may be released and coils *CR* and *GM* remain alive. Contact GM_2 closes the armature circuit. This circuit is from tap *T* on the transformer through the commutating field winding, the armature, overload relay *OL*, either

tube T_6 or T_7 to the transformer, depending on its polarity.

Control-Power Supply. Secondary AS_1, which is part of the transformer whose primary is AP, Fig. 1, supplies power to the control and other circuits. A circuit for secondary AS_1 is from its center tap through voltage regulating tubes VR_1 and VR_2, resistor R_1, reactor X_1, to either anode of T_5 and to either terminal of AS_1 depending on its polarity. Output of dual-anode tube T_5 is filtered through capacitor C_1 and reactor X_1. Tubes VR_1 and VR_2 maintain 300 v between A and B for control operation.

Power Tubes Grid. Coil DS connects to the anode of the tube T_1 and, as previously explained, is the dc coil of saturable reactor AC, Fig. 1. When coil DS is dead, reactance of reactor AC is at its maximum. Under this condition secondaries BS2T apply a voltage to the grids of T_6 and T_7 that lags the anode volts to give a minimum, set, motor-output speed. As dc current is increased through coil DS, reactance of reactor AC decreases to advance the grid-voltage phase relation with the anode volts of tube T_6 and T_7. These tubes then conduct earlier in the anode voltage wave to raise the voltage across the armature and increase its speed.

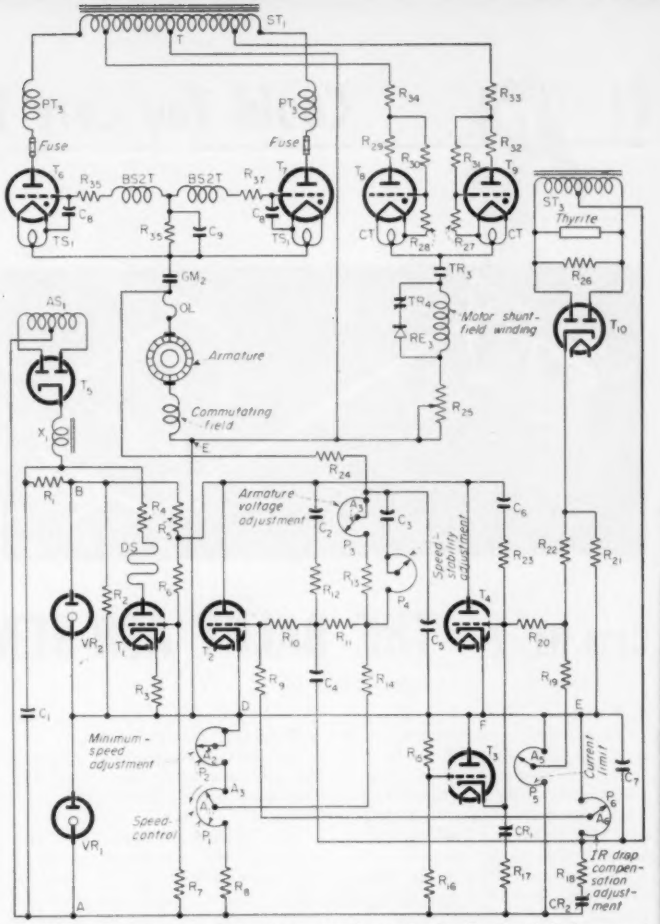
Control Circuits. Current through coil DS is adjusted by speed-control potentiometer P_1, but first let's consider the control circuits. One circuit is through voltage-regulating tube VR_1, resistor R_3, tube T_1, coil DS, resistor R_4, and to rectifier tube T_5. Another circuit is through resistors R_7, R_8, R_5 and R_1 to tube T_5. Voltage drop across R_8 and R_5 biases the grid of tube T_1. This potential is applied from the grid to the cathode through resistor R_3, tube VR_2 and resistor R_2 in parallel to B.

Adjusting the bias on the grid of tube T_1 regulates current flow through this tube and coil DS to adjust motor speed. Bias on tube T_1 grid is adjusted by regulating the current flow through tube T_2. Its circuit is from D through the tube, resistor R_5 and R_1 to rectifying tube T_5.

Current flow through resistor R_5 increases voltage drop across this resistor. This has the same effect as increasing the resistance of R_5 to make the voltage more minus on the grid of tube T_1 to reduce current flow through this tube. As a result, setting speed-control potentiometer P_1 for a higher or lower speed, changes current flow through coil DS to adjust the motor's speed.

Speed Control. Assume contact A_1 on P_1 is set in the position shown. Volts' drop from contact A_1 to D is applied as a minus bias to the grid of T_2, from A_1 through R_{14}, R_{11}, R_{10}, and grid to cathode to D. Voltage across the armature is applied from E to D, cathode and grid of tube T_2, through resistors R_{10}, R_{11}, R_{13}, part of P_3, and R_{24} to OL. In T_2 the grid acts as an anode (grid rectification) for current to flow from the cathode to grid. This current flowing through R_{10} and R_{11} causes a voltage drop that opposes the minus bias applied to the grid by P_1. As a result motor speed comes up to the set value without overshooting.

If contact A_1 is moved to the position shown dotted, minus bias is increased on the grid of tube T_2. Current flow through this tube and R_5 starts to decrease, as will minus bias on the grid of tube T_1. Current through this tube and coil DS increases to phase-shift the bias on the grids of tubes T_6 and T_7. This causes them to increase armature voltage and the motor's speed.



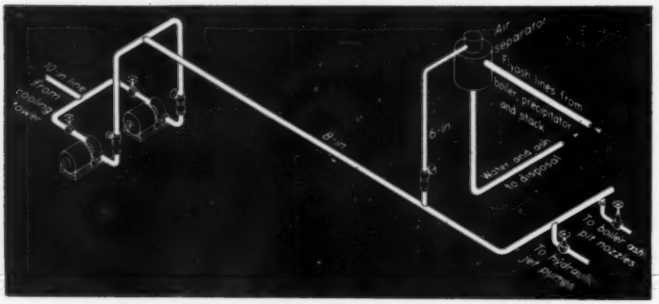
2 Wiring diagram of an electronic dc motor's speed controller that includes current limit, constant shaft speed at any adjustment, speed stability, other features

Voltage increase across the armature increases the current flow through resistors R_{10} and R_{11}. Increased voltage drop across these resistors opposes the increased minus bias applied to the grid of T_2 by the new setting of P_1. Motor speed again gradually comes up to the new set value without overshooting. Also, if for any reason armature voltage increases above normal, tube T_2 and the output of power tubes T_6 and T_7 decreases to hold motor speed constant.

Minimum Speed Adjustment. Minimum-speed potentiometer P_2 sets the lowest speed at which the motor can be operated by P_1 adjustment. When A_2 is in its lowest position, P_2 is cut out of circuit. If contact A_1 is now moved to its top position, this will be the same as connecting A_1 to D to reduce the minus

(*Continued on page* 192)

Could You Cure This Headache?



► **D C Swift, Ebasco Services Inc, continues his series of tough problems that have plagued him in his work as plant starting engineer . . .**

► **Here's a case, or really a series of cases, where the gremlins put in overtime with vim and vigor. Each time Don outlines the headache, stop and see if you can anticipate the cure, then read on . . .**

Case No. 2—THE BALKY ASH-REMOVAL SYSTEM

► A HYDRAULIC ASH SLUICE and water-jet vacuum-type flyash-collecting system served a new 425,000-lb-per-hr pulverized-coal fired boiler. Two 1180-gpm 3600-rpm 427-ft-head horizontal single-stage centrifugal pumps driven by 200-hp 2300-v 3-phase squirrel-cage motors supplied water to the system.

Sluice water flowed from the cooling-tower basin, some 500 ft from the pump, through a 10-in. underground line. Since little debris would come from the basin, no strainers were provided. Water at 175-psig pump discharge pressure, piped to multiple-jet nozzles, produces vacuum to pull dry flyash from hoppers beneath superheater, air preheater and dust collector.

Water passing through reducing orifices sluiced ash out of the boiler hoppers. Water at full pressure fed jet pumps to carry ash through the sluice line to the ash-disposal sump pit. Water and ash from the air separator discharged to the sluice line also.

Service Needed. The station was being rushed to meet a start-up deadline. The boiler had been on light load several days before making the ash system ready for service. Ashes had accumulated to such an extent that any unforeseen delay in removing them would have meant shutting down the boiler and station.

As soon as sluice-water pump piping was completed and electric supply connected we tested motor rotation. We found it wrong (as usual) on both pumps. After reversing motor leads and making final connections, the East pump and motor were given final check for alignment and lubrication. The coupling was connected and filled with heavy oil.

When venting the pump, we discovered there was no water in the suction line. Looking in the basin we found the pump suction several feet above the water level. This level was raised to overflow point, but we had to prime the pump with a hose, holding suction and discharge valves nearly closed. After starting the pump we checked bearing oil rings and adjusted packing glands to give enough leakage. Oil rings were hard to see and after a few minutes we found the one in the outboard bearing was not turning. About then a small amount of smoke came from the bearing and we shut down the motor quickly.

Removing the motor end bell, we discovered the oil ring hung up out of place. After making previous adjustments to the end bells, the installation mechanics had neglected to return the ring to its proper place. The bearing was wiped slightly but the shaft was OK after slight smoothing.

Two Make One. We then started the West pump, but it ran with heavy vibration and noise in the motor. It was not safe to use. To get one operable unit, we interchanged the outboard end bells and bearings of the two motors. This let us get the East pump running so flyash could be moved out of the overflowing soot hoppers of the boiler.

With over 150-psig water pressure at the multiple jets, vacuum was only about 5 in. Hg. We cleaned out the flyash with some difficulty, finding half bricks, welding rods and caked soot in hopper intake valves. Supposedly, the hoppers were thoroughly cleaned before starting the boiler.

Checking the vacuum-jet nozzles we found most of them plugged with welding slag, bits of wood and stones. Much of this could not be removed through the access hole below the nozzles, so we had to unbolt the 6-in. inlet flange to clean out the debris. After a thorough job, vacuum jumped to 17 in. Hg and flyash removal greatly improved. Plugging troubles continued, however, with decreasing frequency until the piping was thoroughly flushed out.

After straightening out this mess, the flyash lines near the vacuum-jet tank sometimes plugged up with wet ash. This was caused by shutting off the jet water before venting the flyash lines. The decreasing vacuum in the lines sucked some of the water trickling from the horizontal supply pipe through the nozzles and back into the normally dry pipes. Opening a vent valve before shutting off water pressure corrected this trouble.

Operation. Shutoff valves on branches to ash sluices and ash jet were far apart and all at some distance from the pumps. Several times the pump became

(*Continued on page* 204)

Power Handbook

PART TWO

Edited by **PHILIP SWAIN**, Editor and **WILLIAM ARROTT**, Assistant Editor

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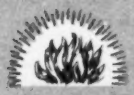
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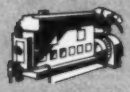
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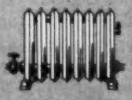
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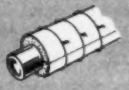
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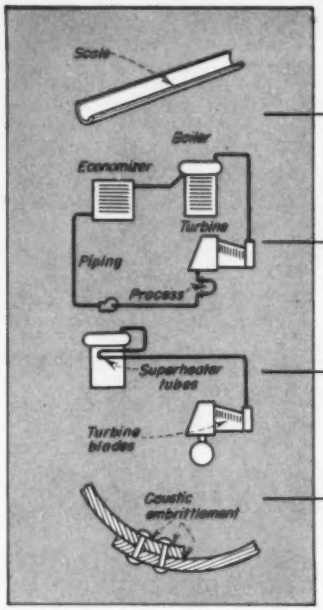
Part two of the *Power* Handbook applies the scientific fundamentals presented in part one (March, 1951) to each of the basic power services and functions listed above. This highly condensed data, used with the common sense and know-how *that only experience provides*, can be the key to a better understanding of power engineering.

FEEDWATER TREATMENT

Compiled by J C McCABE, Associate Editor



THE 4 BASIC JOBS

1 **SCALE.** Calcium and magnesium salts, chiefly, dissolved in boiler water, deposit on tube surfaces as scale when water evaporates. This reduces heat transfer, causes overheating of tube metal. Scale formation is avoided by (1) removing these hardness salts before water enters boiler or (2) adding chemicals to the water to cause these solids to form a soft sludge that can be removed by blowdown.

2 **CORROSION.** Boilers, economizers, feed heaters, piping, etc., become corroded when (1) water is acid or (2) dissolved gases are present. Prescribed remedies are (1) neutralizing water acidity with an alkali (2) removing gases by deaeration, followed by a chemical "scavenger" that absorbs remaining traces and (3) feeding a corrosion inhibitor together with organic substances to protect surfaces of boiler and return lines.

3 **CARRYOVER.** Slugs of water passing over with steam cause erratic superheat, mechanical troubles with engines, turbines. Solids passing over deposit in superheaters, on turbine blades, may spoil materials in process. Alkalinity too high, oil in the water, too many solids, particularly suspended solids, are main causes of foaming. Blowdown and antifoam agents help combat carryover.

4 **EMBRITTLEMENT.** Metal failure from embrittlement is along drum seams, under rivets and at tube ends where water flashing to steam through any small leaks in these highly stressed areas allows any sodium hydroxide in water to concentrate. Embrittlement can be checked by maintaining low hydroxide alkalinity, avoiding leaks at stressed metal, using special inhibiting agents.

IMPURITIES IN BOILER WATER

CLASS	NAME	FORMULA	DIFFICULTY CAUSED	LIMITS OF TOLERANCE	MEANS OF REMOVAL	SPECIAL REMARKS
DISSOLVED GASES	Hydrogen sulfide	H_2S	Corrosion; harmful to process	Under 5 ppm	Aeration and filtration; chlorination	Found principally in ground waters and polluted streams
	Carbon dioxide	CO_2	Decreases pH of water; causes acid corrosion if alkalinity is low	Ratio of alkalinity to CO_2 must be greater than 3 to 1	Aeration; neutralization with alkalies; deaeration	Filming or neutralizing amines used to prevent condensate line corrosion
	Oxygen	O_2	Corrosion and pitting (special form of corrosion)	Under 0.005 ppm for steel-tube economizers, high-pressure boilers	Deaeration; chemical treatment with sodium sulfite	Can also cause pitting of steam lines, turbines, condensate lines, etc.
SUSPENDED SOLIDS	Sediment Turbidity		Sludge, scale, carryover; harmful to process	Under 5 ppm for general purposes	Coagulation; filtration; sedimentation (settling)	
	Organic matter		Foaming; harmful to process	Limits depend on application	Same as above; also chemical treatment	
DISSOLVED AND COLLOIDAL SOLIDS	Oil		Foaming; deposits in boiler	Under 0.5 to 1 ppm	Coagulation; filtration	Mostly enters with condensate
	Hardness (All Ca and Mg salts)	$Ca(HCO_3)_2$, $CaCO_3$ $CaSO_4$, $CaCl_2$ $Mg(HCO_3)_2$, $MgCO_3$ $MgSO_4$, $MgCl_2$	Scale deposits in boiler; forms insoluble curds in washing processes; $MgCl_2$ is also corrosive	0-2 ppm* in high-pressure boilers, under 17 to 25 ppm* for low-pressure boilers with enough sodium alkalinity present	Softening plus internal treatment in boiler	Calcium salts are chief cause of scale in boilers, followed by magnesium. Magnesium scale not as hard as calcium scale
	Sodium alkalinity	$NaHCO_3$ Na_2CO_3 $NaOH$	Foaming; Carbonates form CO_2 in steam to cause return-line corrosion; may contribute to embrittlement	0-5 ppm* for high pressure boilers, depends on individual conditions for low-pressure boilers	Hydrogen exchanger, deionization, acid treatment with deaeration	Sodium salts are found in most waters, are very soluble and can't be removed by chemical precipitation
	Sulfates	SO_4^{--}	Hard scale if calcium is present	100-300 ppm* for general purposes	Deionization	
	Chlorides	Cl^-	Priming, foaming if present in large amounts	Depends on individual conditions	Deionization	
	Iron Manganese	Fe^{++} Mn^{++}	Deposits in boiler if present in large amounts; harms process	Under 0.3 ppm for general purposes	Aeration plus filtration; ion exchange	
	Silica	SiO_2	Hard scale in boilers, turbine-blade deposits	Under 10-15 ppm in concentrated salines of high-pressure boilers if alkalinity is low; to under 3-5 ppm to avoid turbine deposits	Deionization; lime-soda process with addition of ferric sulfate (cold) or Mg reagent (cold or hot)	When combined with aluminum salts forms extremely hard scale in boilers.

*ppm as $CaCO_3$

BASIC WATER CHEMISTRY

SOME COMMON ELEMENTS

Symbol	Element	Atomic weight	Valence	Equivalent weight
Al	Aluminum	27.0	+3	9.0
Ca	Calcium	40.1	+2	20.05
C	Carbon	12.0	Variable	...
Cl	Chlorine	35.46	Variable	35.46
Fe''	Iron (Ferrous)	55.8	+2	27.9
Fe'''	Iron (Ferric)	55.8	+3	18.6
H	Hydrogen	1.0	+1	1.0
Mg	Magnesium	24.3	+2	12.15
N	Nitrogen	14.0	Variable	...
K	Potassium	39.1	+1	39.1
O	Oxygen	16.0	−2	8.00
P	Phosphorus	31.02	Variable	...
Na	Sodium	23.0	+1	23.0
S	Sulphur	32.0	Variable	...
Si	Silicon	28.06	+4	14.03

COMMON ACID RADICALS

Formula	Name	Molecular weight	Valence	Equivalent weight
HCO_3	Bicarbonate	61.0	−1	61.0
CO_3	Carbonate	60.0	−2	30.0
Cl	Chloride	35.46	−1	35.46
NO_3	Nitrate	62.0	±1	62.0
OH	Hydroxide	17.0	−1	17.0
PO_4	Phosphate	95.0	−3	31.66
SO_3	Sulphite	80.0	−2	40.0
SO_4	Sulphate	96.06	−2	48.03

ELEMENTS, COMPOUNDS. Matter is made of one or more of 92 basic substances called elements. Two or more elements, chemically joined, form entirely different substances called compounds. Smallest size compound that can exist without breaking down into its basic elements is a molecule.

CHEMICAL SYMBOLS. Each element has a symbol. Hydrogen is *H* and oxygen *O*. A molecule of water is H_2O, meaning two atoms of hydrogen and one of oxygen for each molecule of water.

VALENCE is the combining power of elements to make compounds. Some valences are (−), others (+). In a compound molecule, (−) and (+) must equal. So it takes two hydrogen atoms with (+1) valence for each (−2) valence oxygen atom.

ATOMIC OR MOLECULAR WEIGHTS are relative weights of atoms, molecules. Water has two parts by weight of hydrogen and 16 parts of oxygen. Molecular weight of H_2O is then $1+1+16=18$.

EQUIVALENT WEIGHT is pounds of a substance chemically equivalent to 1 lb hydrogen. (See "Water Analysis," next page.)

IONS, CATONS, ANIONS. Pure water contains some electrically charged separated parts of molecules called ions: the hydrogen ion (H^+) and the hydroxyl ion (OH^-). When any substance dissolves in water, it ionizes — breaks down into ions. Some ions are (+) charged — cations; others (−) — anions. Each ion's charge acts like a valence. When a molecule ionizes, number of (+) charges must equal number of (−) charges, per molecule. In a solution total(+) charges must equal total (−).

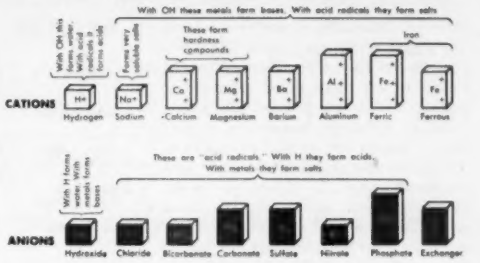
ACIDITY, ALKALINITY, pH. In pure water, number of (H^+) and (OH^-) ions are equal. Water is then neutral. But many substances' dissolved in water add more (H^+) or (OH^-) ions. When more (H^+) than (OH^-) exist, water is *acid*. When more (OH^-) than (H^+) exist, water is *alkaline*. But product of (H^+) and (OH^-) ions present is a constant at any given temperature. Doubling (H^+) halves (OH^-), vice versa.

So merely measuring (H^+) ion concentration tells how acid or alkaline a solution is. For this the pH scale, ranging from 0 to 14, was invented. A neutral solution has a pH of 7.0, but becomes more and more acid as pH decreases from 7.0 and more and more alkaline as pH increases from 7.0.

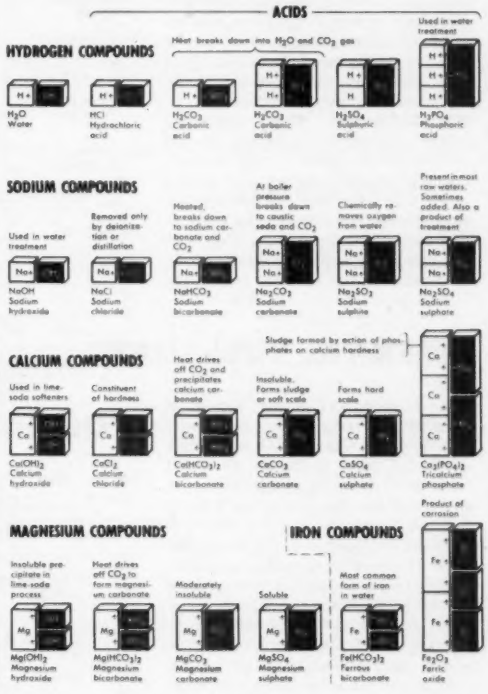
ACIDS, BASES, SALTS. Ions may be charged atoms or charged groups of atoms, called radicals. Compounds of (H^+) cations and acid radicals are called *acids* because they add (H^+) ions when dissolved. Compounds with metal cations, and (OH^-) anions increase alkalinity, and are called *bases*. Salts (metal cations with acid radicals) add neither (H^+) nor (OH^-).

HARDNESS means the presence of scale-forming calcium or magnesium salts in water. Carbonate or bicarbonate salts contribute *carbonate or temporary hardness* — heat breaks down these radicals into CO_2 and water. Sulphates, etc. contribute *non-carbonate or permanent hardness* — they are unaffected by heat.

PRINCIPAL CATIONS AND ANIONS

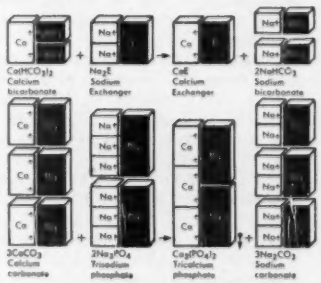


IMPORTANT COMPOUNDS


ACIDS
HYDROGEN COMPOUNDS
Heat breaks down into H_2O and CO_2 gas
Used in water treatment
H_2O Water
HCl Hydrochloric acid
H_2CO_3 Carbonic acid
H_2CO_3 Carbonic acid
H_2SO_4 Sulphuric acid
H_3PO_4 Phosphoric acid
SODIUM COMPOUNDS
Used in water treatment
Removed only by deionization or distillation
Heated, breaks down to sodium carbonate and CO_2
At boiler pressure, breaks down to caustic soda and CO_2
Chemically removes oxygen from water
Present in most raw waters. Sometimes added. Also a product of treatment
NaOH Sodium hydroxide
NaCl Sodium chloride
$NaHCO_3$ Sodium bicarbonate
Na_2CO_3 Sodium carbonate
Na_2SO_3 Sodium sulphite
Na_2SO_4 Sodium sulphate
CALCIUM COMPOUNDS
Sludge formed by action of phosphates on calcium hardness
Used in lime-soda softeners
Constituent of hardness
Heat drives off CO_2 and precipitates calcium carbonate
Insoluble. Forms sludge or soft scale
Forms hard scale
$Ca(OH)_2$ Calcium hydroxide
$CaCl_2$ Calcium chloride
$Ca(HCO_3)_2$ Calcium bicarbonate
$CaCO_3$ Calcium carbonate
$CaSO_4$ Calcium sulphate
$Ca_3(PO_4)_2$ Tricalcium phosphate
MAGNESIUM COMPOUNDS
IRON COMPOUNDS
Product of corrosion
Insoluble precipitate in lime-soda process
Heat drives off CO_2 to form magnesium carbonate
Moderately insoluble
Soluble
Most common form of iron in water
$Mg(OH)_2$ Magnesium hydroxide
$Mg(HCO_3)_2$ Magnesium bicarbonate
$MgCO_3$ Magnesium carbonate
$MgSO_4$ Magnesium sulphate
$Fe(HCO_3)_2$ Ferrous bicarbonate
Fe_2O_3 Ferric oxide

TYPICAL REACTIONS

Equations show how substances exchange anions and cations in solution to form new substances. Top shows reaction in sodium exchanger. Bottom shows internal phosphate treatment. Arrow↓ means substance precipitates out



EXTERNAL TREATMENT

External treatment is used to remove impurities in raw makeup before it enters the boiler cycle. Two forms of treatment are used, either separate or together: (1) *mechanical* – including aeration, filtration, deaeration, coagulation, sedimentation and evaporation to remove suspended solids and some dissolved gases, (2) *chemical* – to remove hardness, alkalinity, dissolved solids and silica. These chemical (or softening) methods are usually one of two types: (1) those that precipitate impurities and (2) ion exchangers.

PRECIPITATION. Certain chemicals introduced to raw water will react with dissolved impurities to form new insoluble compounds that come out of solution (precipitate). Examples: lime, soda, phosphate which precipitate calcium and magnesium hardness.

ION EXCHANGE. Other materials, called exchangers – including natural and synthetic zeolites – will actually give up harmless anions and cations to the raw water and hold back undesirable anions or cations. (See example for sodium exchanger on page 83).

Table right compares results of ten different chemical external treatments.

RESULTS OF VARIOUS EXTERNAL TREATMENTS

Method	Final hardness, ppm as $CaCO_3$	Alkalinity reduction	Total solids reduction	CO_2 in steam	Final silica content	Must water be clear?	Skill to operate
1. Sodium exchanger	0-2	None	Increase	High if alkalinity high	Not reduced	Yes	Low
2. Sodium exchanger plus acid	0-2	Up to 100% if desired	None	As low as desired	Not reduced	Yes	Medium
3. Hydrogen and sodium exchangers	0-2	Up to 100% if desired	Reduced with alkalinity	Same as 2	Not reduced	Yes	Medium
4. Cold lime soda	34-85 Depending on excess soda	Reduced by degree of removal of $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$	Reduced with alkalinity	Depends on excess soda, usually low	Reduced	No, but SiO_2 removal is spoiled by very high turbidity	High
5. Cold lime plus exchanger	0-2	Same as 4	Same as 4	Same as 4	Same as 4	Same as 4	High
6. Hot lime soda	17-25	More than 4	More than 4	A little lower than 4	1-2 ppm; depends on amount of reagent	Same as 4	High
7. Hot lime soda plus hot phosphate	0-2	Same as 6	Same as 6	A little lower than 4	Same as 6	Same as 4	High
8. Hot lime soda plus exchanger	0-2	More than 6	More than 4	A little lower than 6	Same as 6	Same as 4	High
9. Hot phosphate alone	0-2	Little	Little	Same as 7	Not reduced	No	High
10. Deionization	0-2	Nearly 100%	Nearly 100%	As low as desired	Depends on anion exchanger, can be as low as 0-2 ppm	Yes	Medium

INTERNAL TREATMENT

Internal treatment is the feeding of chemicals directly to the raw water or into the boiler to: (1) precipitate impurities as a sludge in the water rather than as scale on the boiler metal, (2) condition the sludge to keep it from sticking to the metal so it can be removed by blowdown, (3) adjust the water composition to make it non-corrosive. Table at right lists some of the materials used to accomplish these three objectives. Commercial "boiler compounds," designed for a wide range of low- and medium-pressure boilers, include various combinations of these basic treatment materials. For high-pressure boilers, it's more common to select the individual ingredients separately according to the individual installation.

BLOWDOWN. As well as removing the sludge formed by treatment, blowdown is often used to control the solids concentration in boiler water. Concentration of chloride ions in water serves as a good indication of total dissolved solids, so amount of blowdown is often determined by: blowdown (% of makeup) = 100 (Cl in feedwater/Cl in boiler water). However if solids concentration is too high, amount of blowdown required becomes excessive.

CHEMICALS USED IN INTERNAL TREATMENT

PURPOSE	NAME	FORMULA	ACTION	REMARKS
CORROSION PROTECTION	Sodium hydroxide (caustic soda)	NaOH	Increases alkalinity, raises pH, precipitates magnesium	Contains no carbonate, so does not favor formation of CO_2 in steam. Alkalinity must be carefully controlled; excess caustic soda may aid caustic embrittlement
	Sodium carbonate (soda ash)	Na_2CO_3	Increases alkalinity, raises pH, precipitates hardness	Low cost, more easily handled than caustic soda. $CaCO_3$ forms scale; soda ash breaks down releasing CO_2 with steam; alkalinity must be controlled. Sludge conditioning needed
	Sodium silicate (water glass)	Na_2SiO_3	Coats boiler metal	Protects against corrosion in low-pressure boilers using soft waters
	Amines	Ammonia derivatives	Prevent CO_2 corrosion	Pass over with steam to prevent corrosion in condensate line
	Sodium sulfite	Na_2SO_3	Prevents O_2 corrosion	A scavenging agent used to neutralize residual oxygen not removed by deaeration--ferrous hydroxide, also used. Sulfite may break down to H_2S in steam
HARDNESS PRECIPITATION	Sodium phosphates	NaH_2PO_4 Na_2HPO_4 Na_3PO_4 $NaPO_3$	Precipitate calcium as calcium phosphate, $Ca_3(PO_4)_2$ or preferably calcium hydroxyphosphate, $Ca_5(PO_4)_3.CaOH_2$	pH must be kept at 9.5 or above for reaction to take place. Proper compound must be chosen to adjust pH to best value. Finely divided calcium phosphate favors carryover. Sludge conditioning needed
	Sodium aluminate	$Na_2Al_2O_4$	Precipitates calcium and magnesium	Forms jelly-like sludge.
SLUDGE CONDITIONING	Tannins, lignins	Organics of varying constitution	Prevent feed line deposits, coat scale crystals to prevent their sticking to metal	Used with soda ash or phosphates. Are inert with respect to hardness removal. Breakdown under heat, hard to control. Also inhibit (slow down) embrittlement as does sodium nitrate, Na_2NO_3
	Starch	$(C_6H_{10}O_5)x$	Same as tannins	Forms slimy coating to prevent scale. Breaks down under heat; no control
	Reactive colloids	Complex organics	Provide fluid sludge, minimize carryover	Will react with calcium and magnesium and adsorb scale crystals but have no direct control

CONTROLLING TREATMENT

Whether to use external or internal treatment, or both, depends on the individual case. Smaller plants, in general, tend more toward inexpensive internal treatment. But as hardness or boiler pressure increase the shift is toward external treatment, followed in many cases by supplementary internal treatment. Two top tables give general limits for hardness and total solids in the boiler water. When hardness is higher than values listed, external treatment is recommended. Likewise when total solids can not be kept within bounds by blowdown alone, external treatment is recommended. Bottom table lists general standards for internally-treated boiler water according to pressure. The PO_4 excess is to form barrier against possible scale.

PERMISSIBLE HARDNESS IN MAKEUP

Pressure, psi	Phosphate control	Carbonate-organic control*
Up to 200	35 ppm (2 gpg)	85 ppm (5 gpg)
200 to 450	25 ppm (1.5 gpg)	50 ppm (3 gpg)
450 to 900	8 to 17 ppm (0.5 to 1.0 gpg)	Not desirable
900 and over	Less than 8.0 ppm (½ gpg)	Not desirable

*Usually some phosphate is used and the mixed sludge is considered less adherent than calcium phosphate alone.

**Alkalinity not to exceed 20% of total concentration. Soluble solids plus suspended solids not to exceed soluble solids by over 5%. Oil or grease that can be extracted by sulfuric ether or chloroform not to exceed 7 ppm

TOTAL SOLIDS (From ABMA)**

Boiler pressure, psi	Total solids, ppm
0 to 300	3500
301 to 450	3000
451 to 600	2500
601 to 750	2000
751 to 900	1500
901 to 1000	1250
1001 to 1500	1000

SUGGESTED CONTROLS FOR INTERNAL TREATMENT

	Operating pressure, psi			
	Up to 250	251 to 450	451 to 900	900 and over
H	0.0	0.0	0.0	0.0
OH, ppm as $CaCO_3$	150	130	100	50 to 80
Total alkalinity, ppm as $CaCO_3$	200	160	120	60 to 100
Phosphate, ppm as PO_4	20 to 50	20 to 50	20 to 50	20 to 50
Silica, ppm as SiO_2	Up to 200	50 to 60	30 to 60	5 to 20
Total solids, ppm	3500	3000	1500 to 2500	1000 to 1500
Suspended solids, ppm*	500	400	300	50 to 200

*Values shown are higher than those given by the ABMA. This is possible through the use of antifoams and sludge conditioners currently available. In fact, still higher values are often permissable

WATER ANALYSIS

Tests may be reported several different ways. The three analyses in next column are all for the same water.

IONIC — as $CaCO_3$. Most common way to report analyses is by *parts per million* weight of solution (ppm) of the various ions tested for. These can be reported as *ppm* of each constituent on *its own weight basis*, or more commonly as *ppm of $CaCO_3$* to put each constituent (except silica, total solids and other exceptions) on a common unit weight basis. With common base individual constituents can be added and subtracted. (Example: Total hardness, ppm as $CaCO_3$, *minus* calcium, ppm as $CaCO_3$, *equals* magnesium, ppm as $CaCO_3$.)

HYPOTHETICAL. This is an old-fashioned way of reporting analysis that assumes ions are probably combined into certain compounds. Actually only the ions can be measured themselves.

EQUIVALENT PER MILLION. Where a lot of computation is involved, analyses are converted to an *equivalent per million* (epm) basis to reduce all constituents to a common denominator. To convert to *epm*, divide *ppm* of constituent by its *equivalent weight*. If it's *ppm as $CaCO_3$*, divide by 50, the equivalent weight of $CaCO_3$ (from tables page 83: 20 for Ca plus 30 for CO_3 equals 50).

Epm can also be used to convert from *ppm as $CaCO_3$* to actual *ppm*. Example: Top line of bottom table — 198 ppm of calcium as $CaCO_3 \div 50 =$ 3.96 epm; $3.96 \times 20 = 79$ ppm as Ca.

Note: dividing epm into (+) and (−) columns, total (+) should equal total. (−) if all constituents have been tested for. If (−) is greater than (+), difference is usually sodium and added to (+) column. If (+) is higher, missing (−) is frequently nitrate.

ALKALINITY. This is often reported as ppm as $CaCO_3$ of *P* and *M* alkalinity. This can be converted into ppm of OH, CO_3 and HCO_3 radicals by these rules.

1. If $P = O$, M is all HCO_3
2. If $P = M$, M is all OH
3. If $P = \frac{1}{2}M$, $2P = CO_3$
4. If $2P$ is more than M, $2(M - P) = CO_3$ and $2P - M = OH$
5. If $2P$ is less than M, $2P = CO_3$, $M - 2P = HCO_3$

So alkalinity in analyses shown here is all HCO_3 since *P* alkalinity is zero.

IONIC — as $CaCO_3$

Hardness as $CaCO_3$	250
Calcium as $CaCO_3$	198
Magnesium as $CaCO_3$	52
"P" alkalinity as $CaCO_3$	0
"M" alkalinity as $CaCO_3$	160
Sulfate as $CaCO_3$	58
Chloride as $CaCO_3$	68
Silica as SiO_2	5
Dissolved solids	413

HYPOTHETICAL (Grains per U.S. gal.)

Calcium bicarbonate as $Ca(HCO_3)_2$	15.2
Calcium sulfate as $CaSO_4$	3.0
Magnesium sulfate as $MgSO_4$	1.4
Magnesium chloride as $MgCl$	1.8
Sodium chloride as NaCl	2.5
Silica as SiO_2	0.3

IONIC WITH EQUIVALENT

	As $CaCO_3$ ppm	(+) epm	(−) epm	Ionic ppm
Calcium (Ca)	198	3.96		79
Magnesium (Mg)	52	1.04		13
Bicarbonate (HCO_3)	160		3.20	195
Sulfate (SO_4)	58		1.16	56
Chloride (Cl)	68		1.36	48
Sodium (Na) (difference between + and −)		0.72		17
Total dissolved solids (not including silica)				408
(cations = anions)		5.72	5.72	

CONVERSION FACTORS

1 cu ft	7.5 gal
1 cu ft of water	62.4 lb
epm	Equivalent per million. A unit chemical equivalent weight per million units weight of solution.
1 ft head (water)	0.434 psi
1 grain per U. S. gal (gpg)	17.1 ppm
1 gram	15.43 grains
1 gram per min	3.18 lb per day
1 Imperial gal	1.2 U. S. gal
1 Imperial gal water	10 lb
1 in. mercury (Hg)	0.49 psi
1 lb	454 grams
1 lb	7000 grains
1 liter	1.06 quarts
1 liter	1000 milliliters
	1 ml per gal of a solution containing 3.78 grams per liter is a 1-ppm treatment.
1 ounce (dry)	438 grains
1 ounce (dry)	28.4 grams
ppm	parts per million. A measure of proportion by weight. It is equivalent to a unit weight per million units weight of solution.
1 ppm	0.0584 grains per U.S. gal
1 ppm	8.35 lb per million U.S. gal
120 ppm	1 lb per 1000 U.S. gal
psi	pounds per sq in
1 psi	2.04 in. of mercury
1 psi	2.31 ft head (water)
1 U.S. gal	231 cu in
1 U.S. gal	3.785 liters
1 U.S. gal water	3785 ml
1 U.S. gal water	8.33 lb
1 U.S. gal	0.83 Imperial gal

NOTE: Following tables are adapted from "Modern Trends in Industrial Water Treatment" by R C Ulmer and E A Lowenthal, *The Oil and Gas Journal*, April 13, 1950: "Results of various external treatments. Permissible hardness in makeup and Suggested controls in internal treatment." Other tables have been freely adapted from material published by W H & L D Betz and the Liquid Conditioning Corp.

FUELS & COMBUSTION

Compiled by P W SWAIN, Editor

COMBUSTION YARDSTICKS

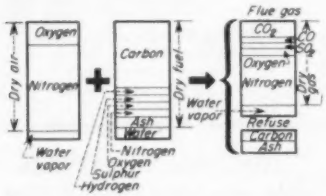
Combustion is usually figured to (1) find out how a fuel is performing under actual conditions and determine its losses or (2) to estimate a fuel's performance under given conditions and determine the theoretical amount of air required for perfect combustion.

Tools for figuring combustion are analyses of fuel, flue-gas and refuse. While not all of these are always available, this section shows how to use whatever data are available plus short-cut methods for estimating losses.

CONTROLLING LOSSES. Fuel's heat is wasted four ways:

1. *Dry-gas loss* — heat carried up the stack. Reduced by cutting down excess air(raising CO_2), keeping tubes clean.
2. *Incomplete-combustion loss* — fuel not completely burned (CO high). Reduced by more air, better mixing.
3. *Moisture loss* — heat absorbed by moisture in fuel and air. This is fixed by fuel and humidity, but is small.
4. *Unaccountable losses* — includes radiation and combustibles in refuse (sometimes considered a separate loss).

CHEMISTRY OF FIRE



AIR + FUEL → PRODUCTS

Combustion is the combination of oxygen and combustible material, with rapid evolution of heat. For combustion to take place, (1) combustible must be gasified, (2) mixture of oxygen and combustible must be within flammable range, not too rich or too lean and (3) air-fuel mix must be above *ignition temperature*.

Most often the required oxygen is supplied in air, which is about 21% oxygen by volume – 23% by weight.

BURNING CARBON. When pure carbon burns completely with pure oxygen:

2 C + 2 O_2 → 2 CO_2
24 parts + 64 parts → 88 parts
1 lb + 2.67 lb → 3.67 lb + 14,093 Btu

(Note: "parts" in second line are molecular weights from table below times number of molecules. Number of parts on both sides of equation are equal. Weights are in proportion to parts.)

Excess air must generally be supplied for complete combustion. Then products of combustion will include excess oxygen (unchanged) plus nitrogen in total air supplied. Nitrogen passes through combustion unchanged.

BURNING CARBON TO CO. If there is not enough air, carbon in fuel burns incompletely to the poison gas CO (carbon monoxide), releasing only about one-third the heat it would if burned completely to CO_2. Formula is:

2 C + O_2 → 2 CO
24 parts + 32 parts → 56 parts
1 lb + 1.33 lb → 2.33 lb + 3,950 Btu

This 2.33 lb of CO can later be burned to give up the rest of the 14,093 Btu originally in the 1 lb of carbon:

2 CO + O_2 → 2 CO_2
56 parts + 32 parts → 88 parts
2.33 lb + 1.33 lb → 3.67 lb + 10,143 Btu

HYDROGEN. Hydrogen burns with oxygen to form water, H_2O:

2 H_2 + O_2 → 2 H_2O
4 parts + 32 parts → 36 parts
1 lb + 8 lb → 9 lb + 61,100 Btu

SULFUR. Although mainly a corrosion nuisance, sulfur does contribute heat:

S + O_2 → SO_2
32 parts + 32 parts → 64 parts
1 lb + 1 lb → 2 lb + 3,983 Btu

FUELS AND ANALYSIS

All fuels are made up of varying proportions of the substances listed in table at right. Not listed is ash – mineral impurities that don't burn but do present a disposal problem. Fuel properties can be reported two ways – by *ultimate* analysis or by *proximate* analysis.

ULTIMATE ANALYSIS. This lists all the various chemical constituents, carbon, hydrogen, oxygen, etc, plus ash as percents by weight. However any moisture present is broken down into hydrogen and oxygen.

PROXIMATE ANALYSIS. (Not "approximate") This is the more common form of analysis for coal. It lists fuel constituents as percents by weight of moisture, volatile, fixed carbon and ash. Volatile is tarry substance driven off when coal is heated in an air-tight retort to make coke; it consists mainly of carbon-hydrogen compounds called hydro-carbons. When the coke left behind is burned in air, the fixed carbon is burned off, leaving behind only the ash. Sulfur is usually reported separately, but its weight is included in the weight of ash for the proximate analysis.

HEATING VALUE. This is reported separately in Btu per lb, but can be estimated from ultimate analysis, next page. Be sure it's *as-fired* heating value; values listed *moisture-free* or *moisture-and-ash free* are too high for fuel as fired.

COMBUSTION ELEMENTS, PRODUCTS

Element or Compound	Formula	Molecular weight	At 14.7 psia, 60 F: Weight, lb per cu ft	At 14.7 psia, 60 F: Volume, cu ft per lb	Nature: Gas or solid	Nature: Combustible	Heat value, Btu: Per pound	Heat value, Btu: Per cu ft at 14.7 psia, 60 F
Carbon	C	12			S	Yes	14093	
Sulphur	S	32			S	Yes	3983	
Hydrogen	H_2	2	.00631	188	G	Yes	61100	325
Carbon monoxide	CO	28	.07385	13.53	G	Yes	4347	322
Methane	CH_4	16	.04233	23.62	G	Yes	23879	1013
Acetylene	C_2H_2	26	.06954	14.38	G	Yes	21500	1449
Ethylene	C_2H_4	28	.07437	13.45	G	Yes	21644	1614
Ethane	C_2H_6	30	.08009	12.49	G	Yes	22320	1792
Oxygen	O_2	32	.08440	11.85	G	No		
Nitrogen	N_2	28	.07421	13.48	G	No		
Air		29 (equiv)	.07636	13.10				
Carbon dioxide	CO_2	44	.1167	8.58	G	No		
Water	H_2O	18						

Table based on values in Perry's Chemical Engineers Handbook, Third edition (pg 1583)

AIR, PRODUCTS FOR PERFECT COMBUSTION

Required combustion air and products for common combustibles burned with theoretical air requirements

Fuel	For 1 mol of fuel					For 1 cu ft of fuel					For 1 pound of fuel					
	Air		Other products (than N_2)			Air		Other products (than N_2)			Air		Other products (than N_2)			
	O_2	N_2	CO_2	H_2O	S_2O	O_2	N_2	CO_2	H_2O	SO_2	O_2	N_2	CO_2	H_2O	SO_2	
C	1.0	3.76	1.0	–	–	–	–	–	–	–	.0833	.313	.0833	–	–	Mols
	379	1425	379	–	–	–	–	–	–	–	31.6	118.8	31.6	–	–	Cu ft
	32.0	105	44.0	–	–	–	–	–	–	–	2.67	8.78	3.67	–	–	Pounds
H_2*	0.5	1.88	–	1.0	–	.00132	.00496	–	.00264	–	.250	.940	–	0.5	–	Mols
	189.5	712	–	–	–	0.5	1.88	–	–	–	94.8	356	–	–	–	Cu ft
	16.0	25.6	–	18	–	.0422	.139	–	.0475	–	8.0	26.3	–	9.0	–	Pounds
S	1.0	3.76	–	–	1.0	–	–	–	–	–	.0312	.1176	–	–	.0312	Mols
	379	1425	–	–	379	–	–	–	–	–	11.84	44.6	–	–	11.84	Cu ft
	32.0	105	–	–	64	–	–	–	–	–	1.0	3.29	–	–	2.0	Pounds
CO	0.5	1.88	1.0	–	–	.00132	.00496	.00264	–	–	.179	.0672	.0357	–	–	Mols
	189.5	712	379	–	–	0.5	1.88	1.0	–	–	6.77	25.4	13.53	–	–	Cu ft
	16.0	52.6	44.0	–	–	.0422	.139	.116	–	–	.571	1.88	1.57	–	–	Pounds
CH_4	2.0	7.52	1.0	2.0	–	.00528	.0198	.00264	.00528	–	.125	.470	.0625	.125	–	Mols
	758	2850	379	–	–	2.0	7.52	1.0	–	–	47.4	178	23.7	–	–	Cu ft
	64.0	210	44.0	36.0	–	.169	.556	.116	.0950	–	4.0	13.17	2.75	2.25	–	Pounds
C_2H_2	2.5	9.40	2.0	1.0	–	.0066	.0248	.00528	.00264	–	.0962	.362	.0769	.0385	–	Mols
	947	3560	758	–	–	2.5	9.40	2.0	–	–	36.4	137	29.15	–	–	Cu ft
	80.0	263	88.0	18.0	–	.211	.694	.232	.0475	–	3.08	10.13	3.38	.692	–	Pounds
C_6H_4	3.0	11.29	2.0	2.0	–	.00792	.0298	.00528	.00528	–	.1071	.403	.0714	.0714	–	Mols
	1137	4280	758	–	–	3.0	11.29	2.0	–	–	40.6	153	27.1	–	–	Cu ft
	96.0	316	88.0	36.0	–	.253	.834	.232	.0950	–	3.43	11.29	3.14	1.286	–	Pounds
C_2H_6	3.5	13.17	2.0	3.0	–	.00923	.0347	.00528	.0079	–	.1167	.439	.0667	.10	–	Mols
	1326	4990	758	–	–	3.5	13.17	2.0	–	–	44.2	166.3	25.3	–	–	Cu ft
	112.0	369	88.0	54.0	–	.296	.972	.232	.1425	–	3.73	12.29	2.93	1.8	–	Pounds

*Varying assumptions for molecular weight introduce a slight inconsistency in the values of air and combustion products from the burning of hydrogen. True molecular weight of hydrogen is 2.02, but the approximate value of 2 is used in figuring the air and combustion products.

Equations explained under "Chemistry of Fire" were only the major reactions on a lb-per-lb-of-fuel basis. Very often in combustion calculations it's necessary to figure fuel, air or products on the basis of cu ft or mols. These have all been calculated above *for theoretical air only*. How to allow for the excess air that's needed for most efficient combustion is explained in the section below.

FIGURING BY MOLS. A *mol* of any substance is defined as a weight in pounds equal to the molecular weight. The beauty of using mols is that for most all gases the volume of a mol is pretty nearly the same at a given temperature and pressure. (At 60 F and 14.7 psia, the volume of a mol of "perfect" gas is 379 cu ft). This means that a mol of carbon is 12 lb, a mol of oxygen is 32 lb and a mol of carbon dioxide is 44 lb. The number of molecules of a substance in an equation can be taken to mean the number of mols of that substance.

So the equation $C + O_2 = CO_2$ actually means 1 mol $C + 1$ mol $O_2 = 1$ mol CO_2. It also means that 12 lb $C + 32$ lb $O_2 = 44$ lb CO_2.

HOW TO USE ULTIMATE ANALYSIS

Here is a typical ultimate analysis of coal reported by test:

	% by weight
Ash	10.49
Sulfur	1.20
Carbon	71.98
Hydrogen	6.47
Nitrogen	1.16
Oxygen	8.70
Total	100.00

FINDING MOISTURE CONTENT. It is commonly assumed that all the oxygen in the fuel is present as moisture. So, since there is one lb of hydrogen for every 8 lb of oxygen in the fuel, the amount of hydrogen tied up as moisture is $0.087 \div 8 = 0.0109$ lb per lb fuel. Total moisture is $0.0109 + 0.087 = 0.0979$ lb, or 9.79% moisture.

FREE HYDROGEN. Free hydrogen is $0.0647 - 0.0109 = 0.0538$ lb, or 5.38%.

ESTIMATING HEAT VALUE. Multiply weights of individual constituents by their heating values, then add:

C: $0.7198 \times 14{,}093 = 10{,}144$
H: $0.0538 \times 61{,}100 = 3{,}287$
S: $0.012 \times 3{,}983 = 48$
Heat value, Btu = 13,479

(Note: This method is only approximate; heating value is usually measured when ultimate analysis is made.)

THEORETICAL AIR. First multiply the weight per lb of each combustible by weight of oxygen it combines with:

C: $0.7198 \times 2.67 = 1.922$
H: $0.0538 \times 8 = 0.430$
S: $0.012 \times 1 = 0.012$
Theoretical $O_2 = 2.364$ lb

Then since air is 23% oxygen by weight, the theoretical air required per lb is $2.36 \div 0.23 = 10.3$ lb of air.

EXCESS AIR. More oxygen is required for best combustion than the theoretical amount. In this example, assume coal is burned with 40% excess air. Excess O_2 will then be $0.4 \times 2.364 = 0.946$ and total O_2 will be $2.364 + 0.946 = 3.31$ lb. Actual air supplied is $3.31 \div 0.23 = 14.4$. Or, $1.4 \times 10.3 = 14.4$ lb.

COMBUSTION PRODUCTS. Since no weight is destroyed in combustion, products must be 1 lb coal + 14.4 lb air = 15.4 lb total products per lb of fuel. However the 0.1 lb ash will normally go into the ashpit, so stack gases will be about $15.4 - 0.1 = 15.3$ lb (actually less, because some good coal always slips into the ashpit). The weight of dry gas will then be total flue gas less moisture content. Moisture brought in by air supply is usually neglected, so moisture content is nine times the total hydrogen weight or $9 \times 0.0647 = 0.58$ lb. So dry-gas weight is $15.29 - 0.58 = 14.71$ lb, made up of:

	Lb	%
SO_2	0.024	0.1
CO_2	2.64	17.9
O_2	0.946	6.5
N_2	11.10	75.5
Total	14.71	100.0

The oxygen is the excess oxygen already figured. Nitrogen is the 0.01 + lb in the fuel plus the nitrogen in air supply (14.4 lb air − 3.31 lb oxygen = 11.09 lb). Sulfur dioxide and carbon dioxide are figured as: $(0.012 \times 2 = 0.024)$ and $(0.7198 \times 3.67 = 2.64)$.

CARBON MONOXIDE. One thing that doesn't show up in calculation is the CO that almost always is present in flue gas, despite excess air. First problem, next page, shows how to figure combustion for this same fuel, using flue-gas analysis with CO.

EXAMPLES

COMBUSTION OF COAL

Given complete analysis of coal and flue gas, determine (per lb of coal) theoretical air, actual air, dry flue gas, moisture in flue gas — also per cent excess air and per cent loss from incomplete combustion.

1. Ult Analysis of Coal (as fired), % by Weight

Ash	10.49
Sulphur	1.20
Hydrogen	6.47
Carbon	71.98
Nitrogen	1.16
Oxygen	8.70
	100.00%

2. Flue-Gas Analysis, Percent by Volume

CO_2	10.2
CO	0.6
O_2	9.2
N_2	80.0
	100.00%

Btu per lb 13,800

3. Figuring Mols of Carbon and Nitrogen in Flue Gas

Flue Gas	%	Mols Gas	Mols C	Mols N_2
CO_2	10.2	10.2	10.2	...
CO	0.6	0.6	0.6	...
O_2	9.2	9.2	...	...
N_2	80.0	80.0	...	80.0
Total mols		100.0	10.8	80.0

4. Weight carbon burned = 10.8 × 12 = 129.6 lb
5. Weight coal burned = 129.6 ÷ 0.7198 = 180.0 lb
6. Mols air supplied = 80.0 ÷ 0.79 = 101.3
7. Weight air supplied = 101.3 × 29 = 2938 lb
8. Ratio air to coal = 2938 ÷ 180.0 = 16.32 lb air per lb coal
9. Moisture produced per lb coal = 0.0647 × 9 = 0.58 lb
10. Dry flue gas per lb coal = coal + air − ash − moisture = 1 + 16.32 − 0.1049 − 0.58 = 16.64 lb
11. Figuring CO loss

Fraction of carbon burning to CO = 0.6 ÷ (10.2 + 0.6) = 0.0555

Weight of carbon to CO = 0.0555 × 0.7198 = 0.040

Heat loss from CO = 0.040 × 10143 = 406 Btu;

Percent heat loss from CO = 100 × 406 ÷ 13,800 = 2.94%

12. Theoretical Air per Pound Coal

	Lb of Combustible	Lb O_2 Required per lb Comb.	Lb O_2 Required
Carbon	0.7198	2.67	1.922
Hydrogen	0.0647	8.00	0.518
Sulphur	0.012	1.00	0.012
Total			2.452
Less oxygen in the coal			0.087
Net oxygen needed			2.365 lb

Theoretical air per lb coal = 2.365 ÷ 0.23 = 10.28 lb air

13. Excess air = 16.32 − 10.28 = 6.04 lb per lb coal
14. Percent excess air = 6.04 ÷ 10.28 = 58.8%

NATURAL GAS

Given volumetric analysis of a natural gas, determine the volumetric analysis of the flue gas if the fuel is burned with 40% excess air (by volume).

1. Gas Analysis by Volume, %

CO	0.60
H_2	1.62
CH_4	94.30
C_2H_4	0.15
H_2S	0.25
O_2	0.40
CO_2	0.85
N_2	1.83
Total	100.00

2. Oxygen, Combustion Products for 100 Mols of Fuel

Gas	Mols	Mols O_2 Needed	Mols Produced CO_2	Mols Produced H_2O	Mols Produced SO_2
CO	0.60	0.30	0.60	....	....
H_2	1.62	0.81	....	1.62	....
CH_4	94.30	188.60	94.30	188.60	....
C_2H_4	0.15	0.45	0.30	0.30	....
H_2S	0.25	0.37	....	0.25	0.25
CO_2	0.85	....	0.85	....	....
Total	....	190.53	96.05	190.77	0.25
Minus O_2 in fuel	....	0.40	....	....	....
	....	190.13	96.05	190.77	0.25

3. Figuring nitrogen in flue gas

N_2 required for 190.13 mols O_2 = 190.13 × 3.76 = 714.9 mols

40% excess N_2 (by volume) = 0.40 × 714.9 = 286.0

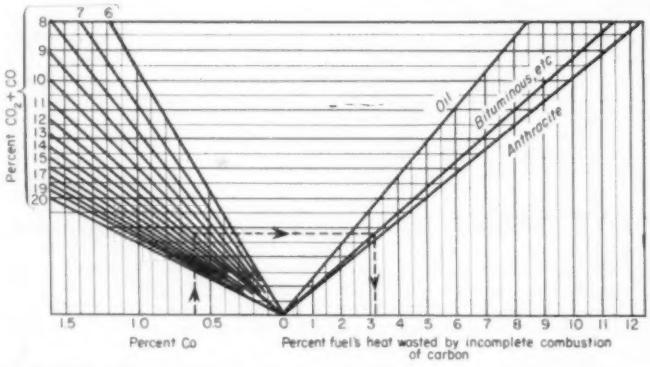
N_2 in fuel = 1.8

N_2 in flue gas = 1002.7 mols

4. Unburned O_2 in flue gas = 0.40 × 190.13 = 76.0 mols
5. Volumetric Gas Analysis (H_2O Disappears)

Gas	Mols	% by Vol
CO_2	96.1	8.2
O_2	76.0	6.5
SO_2	0.2	0.0
N_2	1002.7	85.3
Total	1175.0	100.0

COMBUSTION SHORT CUTS

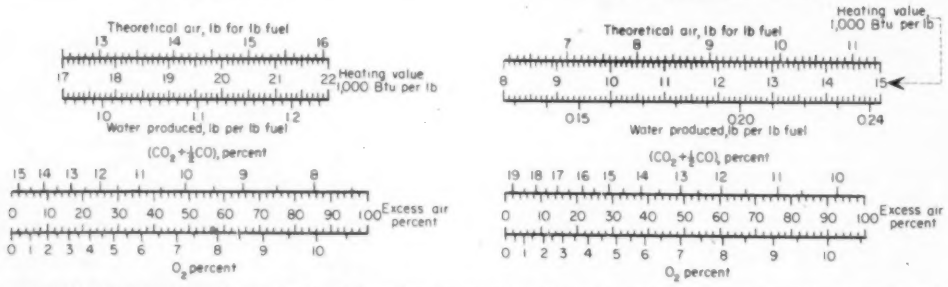


INCOMPLETE COMBUSTION LOSS can be estimated directly from the CO and CO_2 readings of the flue-gas analysis. Dashed line shows solution for problem on facing page

Many plants, especially smaller ones, are not equipped to obtain complete fuel, flue-gas and refuse analyses. So chart and scales were designed for use when only *flue-gas analysis* and fuel's *heating value* are known. Numerous checks have shown this approximate method (example worked out next page) to give results within 2% of those obtained by figuring from ultimate analysis.

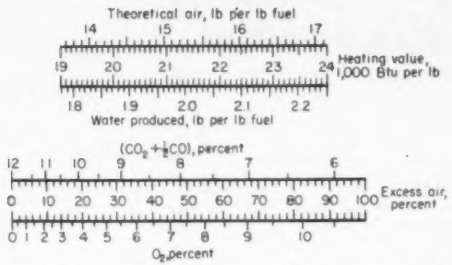
CORRECTING HEATING VALUE. Heating value used should be the *as-fired* value. If it is reported for *dry* or *moisture-free* fuel, multiply heating value by one minus the moisture content to correct for *as-fired* value.

EXAMPLE: Coal with a dry-basis heating value of 12,700 Btu per lb contains 4.5% moisture. As-fired heat value is 12,700 (1.00—0.045)=12,140 Btu per lb.

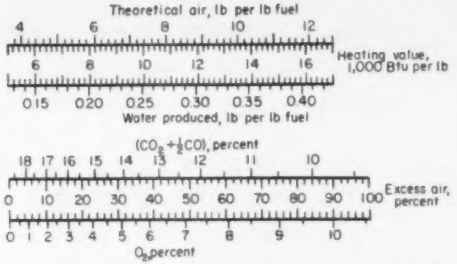

FUEL OIL
Theoretical air, lb for lb fuel
Heating value 1,000 Btu per lb
Water produced, lb per lb fuel
$(CO_2 + \frac{1}{2}CO)$, percent
Excess air percent
O_2 percent
ANTHRACITE COAL
Heating value 1,000 Btu per lb
Theoretical air, lb for lb fuel
Water produced, lb per lb fuel
$(CO_2 + \frac{1}{2}CO)$, percent
Excess air percent
O_2 percent

THEORETICAL AIR REQUIRED and water produced from free hydrogen in fuel can be estimated directly from fuel's heating value

NATURAL GAS


Theoretical air, lb per lb fuel
14 15 16 17
19 20 21 22 23 24
Heating value, 1,000 Btu per lb
18 1.9 2.0 2.1 2.2
Water produced, lb per lb fuel
(CO2 + ½CO), percent
12 11 10 9 8 7 6
0 10 20 30 40 50 60 70 80 90 100
Excess air, percent
0 1 2 3 4 5 6 7 8 9 10
O2 percent

BITUMINOUS, LIGNITE, WOOD


Theoretical air, lb per lb fuel
4 6 8 10 12
6 8 10 12 14 16
Heating value, 1,000 Btu per lb
0.15 0.20 0.25 0.30 0.35 0.40
Water produced, lb per lb fuel
(CO2 + ½CO), percent
18 17 16 15 14 13 12 11 10
0 10 20 30 40 50 60 70 80 90 100
Excess air, percent
0 1 2 3 4 5 6 7 8 9 10
O2 percent

EXCESS AIR is estimated from percent CO_2 + ½CO. If flue-gas analysis is accurate, O_2 should line up with CO_2 + ½CO

SHORT-CUT EXAMPLE

QUICK FIGURING OF BITUMINOUS-COAL COMBUSTION

1. Kind of fuel ..... Bituminous coal
2. Heating value as fired ..... 13,800 Btu per lb
3. Room temperature ..... 80 F
4. Flue-gas temperature ..... 520 F
5. Flue-gas analysis:
   a. CO_2 ..... 10.2%
   b. CO 0.6%
   c. O_2 ..... 9.2%
6. Boiler efficiency (from test) 74.4%

COMPUTATIONS:

7. Theoretical air, from scale ..... 10.2 lb per lb fuel
8. Water produced by burning available hydrogen (scale) 0.35 lb per lb fuel
9. Total water from burning of coal = 0.35 + 0.05 = 0.40 lb per lb fuel
10. Actual air = 175% of theoretical = 1.75×10.2 = 17.9 lb per lb fuel
11. Total flue gas = air + coal − ashes = 17.9 + 1 − 0.2 = 18.7 lb per lb fuel
12. Dry flue gas = total flue gas − water produced = 18.7 − 0.40 = 18.3 lb per lb fuel
13. Sensible heat loss in dry gas = Dry gas weight × temperature rise × specific heat = 18.3 × (520−80) × 0.24 = 1930 Btu per lb fuel
14. Moisture heat loss per lb water = 1000 + ½ flue gas temperature = 1000 + 260 = 1260 Btu
15. Moisture heat loss = loss per lb water × lb water per lb coal = 1260 × 0.4 = 500 Btu per lb fuel
16. Incomplete-combustion loss, from chart 3.2%
17. Heat balance

	Btu per lb fuel	%
a. Dry-gas loss	1,930	14.0
b. Moisture loss	500	3.6
c. Incomplete-combustion loss	440	3.2
d. Unaccounted-for losses	660	4.8
e. Total losses	3,530	25.6
f. Useful heat	10,270	74.4
g. Heating value, Btu per lb fuel	13,800	100.0

18. Calculation of heat balance items:
    a. Dry-gas loss = 1930/13,800 = 14.0%
    b. Moisture loss = 500/13,800 = 3.6%
    c. Incomplete combustion loss = 13,800×0.032 = 440 Btu per lb fuel
    d. Unaccounted losses = 3530−440−500−1930 = 660 Btu per lb fuel
    e. Useful heat = 13,800×0.744 = 10,270 Btu per lb

HOW CALCULATIONS WERE MADE:

Items 1 to 6: This data must be given or obtained.

Item 7: Read from *theoretical-air* scale, bituminous coal.

Item 8: Read scale marked *water produced, lb per lb fuel.* This is water produced by burning free hydrogen in fuel; does not include moisture originally in fuel or air. Air's moisture can be neglected.

Item 9: The 0.05 lb of original moisture per lb of coal is assumed, not measured. Amount is too small for errors to be important.

Item 10: First add CO_2 and one-half the CO to get 10.5. Enter scale marked CO_2+½CO to get 75% excess air. Note that the same scale corresponds to 9% oxygen, showing there is no serious error in original gas analysis.

Item 11: All *weight* fed to a furnace goes up the stack or into the ashpit. Most of it goes up the stack. Stack discharge per lb of coal equals 1 lb plus the air supplied per lb of coal minus the refuse per lb of coal. Refuse contains most of the original ash in the coal and some unburned carbon. Some ash goes up the stack, particularly with pulverized coal, but it is only a small percent of the total weight of stack discharge. Assume (for any bituminous or anthracite coal) 0.2 lb of refuse per pound of coal, for this particular calculation. Neglect refuse for gas or oil.

Item 12: Dry gas and water vapor in flue gas must be separated to calculate the heat carried off by each.

Item 13: This is the largest single loss — product of the weight of dry gas times the temperature difference between stack and room times 0.24, the specific heat of the gas.

Item 14: This formula is based on room temperature of 80 F, but is close enough for 60 to 100 F.

Item 15: Product of the results of Items 9 and 14.

Item 16: Follow dotted lines as shown on large chart, left.

Item 17: From previous computations and given data, fill in the underlined figures. Use 13,800 Btu as 100% to fill in the *percent* column for *a* and *b* and *Btu per lb fuel* column for *c*. Use given boiler efficiency for *f*. Line *e* is *g* minus *f*; *d* is *e* minus *a*, *b* and *c*.

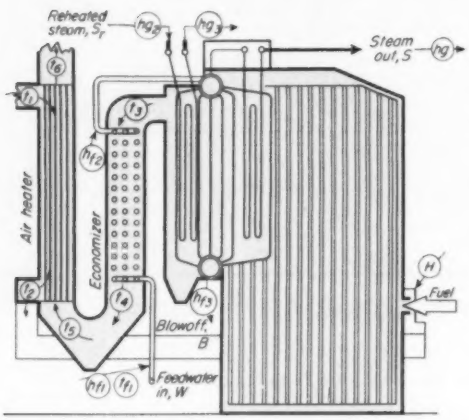
UNACCOUNTED LOSSES include (1) loss of combustible to ashpit (2) radiation from boiler and furnace (3) accumulated errors of measurements and computation. If unaccounted losses run over 5%, or if they vary much from test to test, look for carbon in the refuse, mistakes in data or computations or unusual conditions in steam generator.

CARBON LOSS. The short-cut method on this page assumes that no analyses other than flue-gas are available, and so lumps carbon loss in refuse into the unaccounted losses. If coal's ash content is known, carbon loss can be calculated from measurements of coal fired and refuse produced (assuming negligible carbon loss up the stack).

EXAMPLE: Ash in 1 lb of coal as fired is 0.074 lb, refuse produced per lb of coal is 0.096 lb. Then refuse must contain 0.096−0.074=0.022 lb of combustible per lb of coal fired. Since the volatile has probably been "cooked" off, this can be assumed to be pure carbon with a heating value of 14,090 Btu per lb, so carbon loss in refuse is 0.022x14,090=310 Btu per lb coal.

Compiled by B G A SKROTZKI, Associate Editor

FIGURING EFFICIENCY FROM STEAM TABLES



STEAM GENERATOR showing where to measure temperatures and find enthalpies (from steam tables) for figuring efficiency

Efficiencies are figured according to ASME Test Code for Stationary Steam Generating Units. Enthalpies are in steam tables, pp 89-91, Part One. Remember h_f stands for enthalpy of liquid and h_g for enthalpy of vapor.

STEAM GENERATOR OVERALL EFFICIENCY = Output, Btu per hr / Input, Btu per hr

Output, Btu per hr $= S(h_g - h_{f1}) + S_r(h_{g3} - h_{g2}) + B(h_{f3} - h_{f1})$

S = steam flow, lb per hr
S_r = reheated steam flow, lb per hr (if any)
B = blowoff, lb per hr

Input, Btu per hr $= F \times H$

F = fuel input, lb per hr (as fired)
H = fuel higher heating value, Btu per lb (as fired)

EXAMPLE. Find overall efficiency of steam generator (without reheater) producing 56,000 lb per hr of 600-psia 800-F steam. Continuous blowdown equals 2500 lb per hr, feedwater enters economizer at 300 F. Furnace burns 5958 lb per hr coal, higher heating value of 13,100 Btu per lb.

$$\text{Eff} = \frac{56{,}000(1407.7-269.6) + 2500(471.6-269.6)}{5958 \times 13{,}100} = 0.822 \text{ or } 82.2\%$$

ECONOMIZER EFFICIENCY = Heat absorbed, Btu per hr / Heat available, Btu per hr

Heat absorbed, Btu per hr $= W(h_{f2} - h_{f1})$

W = feedwater flow, lb per hr

Heat available, Btu per hr $= H_g \times F$

H_g = heat available in flue gas, Btu per lb fuel
= heat available in dry gas + heat available in flue-gas vapor, Btu per lb fuel

$$= (t_3 - t_{f1})0.24G + (t_3 - t_{f1})0.46\left\{M_f + 8.94H_2 + M_a[G - C_b - N_2 - 7.94(H_2 - \frac{O_2}{8})]\right\}$$

$$G = \frac{11CO_2 + 8O_2 + 7(N_2 + CO)}{3(CO_2 + CO)} \times (C_b + \frac{S}{2.67}) + \frac{S}{1.60}$$

M_f = lb moisture per lb fuel burned
M_a = lb moisture per lb dry air to furnace
C_b = lb carbon burned per lb fuel burned = C–RC$_r$
C_r = lb combustible per lb refuse
R = lb refuse per lb fuel
H_2, N_2, C, O_2, S, lb of each element per lb of fuel (as fired)
CO_2, CO, O_2, N_2, percentage parts of volumetric analysis of dry combustion gas entering economizer

EXAMPLE. Steam generator in previous example burns coal with ultimate analysis of 68.5% C, 5% H_2, 8.9% O_2, 1.2% N_2, 3.2% S, 8.7% ash and 4.5% moisture. Air enters unit with dry-bulb temp of 63 F and wet-bulb of 56 F. Psychrometric chart shows 56 grains of vapor held by each lb of dry air for this condition. Carbon in refuse is 7% while refuse is 0.093 lb per lb of fuel. Feedwater leaves economizer and enters at 300 F while flue gas enters at 850 F with analysis of 15.8% CO_2, 2.8% O_2 and 81.4% N_2.

Heat absorbed = (56,000+2500)(342.8–269.6) = 4,283,000 Btu per hr

$C_b = 0.685 - 0.093 \times 0.07 = 0.678$ lb per lb fuel

$$G = \frac{11 \times 0.158 + 8 \times 0.028 + 7 \times 0.814}{3 \times 0.158}(0.678 + \frac{0.032}{2.67}) + \frac{0.032}{1.60}$$

= 11.18 lb per lb fuel

$$H_g = (800-300)0.24 \times 11.18 + (800-300)0.46\left\{0.045 + 8.9 \times 0.05 + \frac{56}{7000}[11.18 - 0.678 - 0.012 - 7.94(0.05 - \frac{0.089}{8})]\right\}$$

= 1473 Btu per lb fuel

Heat available = 1473 × 5958 = 8,770,000 Btu per hr

Economizer efficiency $= \frac{4{,}283{,}000}{8{,}770{,}000} = 0.488$ or 48.8%

AIR HEATER EFFICIENCY = Heat absorbed, Btu per lb fuel / Heat available, Btu per lb fuel

Heat absorbed, Btu per lb fuel $= A_h(t_2 - t_1)(0.24 + 0.46M_a)$

A_h = air flow through heater, lb per lb fuel = A–A_m
A = total air to furnace, lb per lb fuel
= G–C_b–N_2–7.94($H_2 - \frac{O_2}{8}$)
G = similar to economizer but based on gas at furnace exit
A_m = external air supplied by mill fan or other source, lb per lb fuel

Heat available, Btu per lb fuel
$= (t_5 - t_1)0.24G + (t_5 - t_1)0.46(M_f + 8.94H_2 + M_aA)$

G and A similar to G and A, but based on gas entering heater
Other factors same as for economizer

EXAMPLE. Steam generator in previous example has gas analysis at air heater inlet: 15.0% CO_2, 3.6% O_2, 81.4% N_2. At exit of furnace analysis runs: 16.0% CO_2, 2.6% O_2, 81.4% N_2. Air enters air heater at 63 F with 56 grains of vapor per lb dry air, leaves at 480 F. Gas enters air heater at 570 F. 15% of air to furnace comes from mill fan.

$$G = \frac{11 \times 0.16 + 8 \times 0.26 + 7 \times 0.184}{3 \times 0.16}(0.678 + \frac{0.032}{2.67}) + \frac{0.032}{1.60}$$

= 11.03 lb per lb fuel

$$A = 11.03 - 0.69 - 0.012 - 7.94\ (0.05 - \frac{0.089}{8})$$

= 10.02 lb per lb fuel

Heat absorbed $= (1-0.15)\ 10.02\ (480-63)\ (0.24 + 0.46 \times \frac{56}{7000})$
= 865.5 Btu per lb fuel

$$G = \frac{11 \times 0.15 + 8 \times 0.036 + 7 \times 0.814}{3 \times 0.15}(0.678 + \frac{0.032}{2.67}) + \frac{0.032}{1.60}$$

= 11.72 lb per lb fuel

$$A = 11.72 - 0.69 - 0.012 - 7.94\ (0.05 - \frac{0.089}{8}) = 10.71 \text{ lb per lb fuel}$$

Heat available $= (570-63)\ 0.24 \times 11.72 + (570-63)\ 0.46\ (0.045 + 8.94 \times 0.05 + \frac{56}{7000} \times 10.71) = 1561$ Btu per lb fuel

Air heater efficiency $= \frac{865.5}{1561} = 0.554$ or 55.4%

OPERATING HINTS

Following are some of the methods for checking on boiler operation.

INSTRUMENTS. One common aid is the steam-flow air-flow meter. When air-flow pen is properly calibrated, maintaining proper air-fuel ratio is possible by keeping steam-flow and air-flow pens together at all times. But calibration against combustion-gas analysis should be made periodically as fouling of boiler passes upsets air-flow readings.

CO_2 meters and oxygen meters serve as a measure of excess air. However the CO_2 reading for a given percent excess air varies from fuel to fuel; so the proper operating point must be redetermined if fuel analysis changes widely. The O_2 reading for a given percent excess air varies much less with fuel characteristics.

One of the best ways to check the general condition of a steam generator is the flue-gas temperature at given steam outputs. Gradually increasing temperatures indicate fouling of heat-transfer surfaces. When temperatures drop below design temperature, there may be excessive air leakage.

STEAM TEMPERATURES. Superheater outlet temperatures are affected by:

1. *Steaming load.* Increasing load (1) raises temperature on convection superheater because gas leaving furnace is hotter (2) lowers temperature on radiant superheater because more steam flows with no increase in radiant-heat transfer. Combination superheaters may hold constant temperature.

2. *Excess air.* Increasing excess air (1) raises superheat on convection type because more air flows over tubes and (2) lowers superheat on radiant types because furnace gas is cooler.

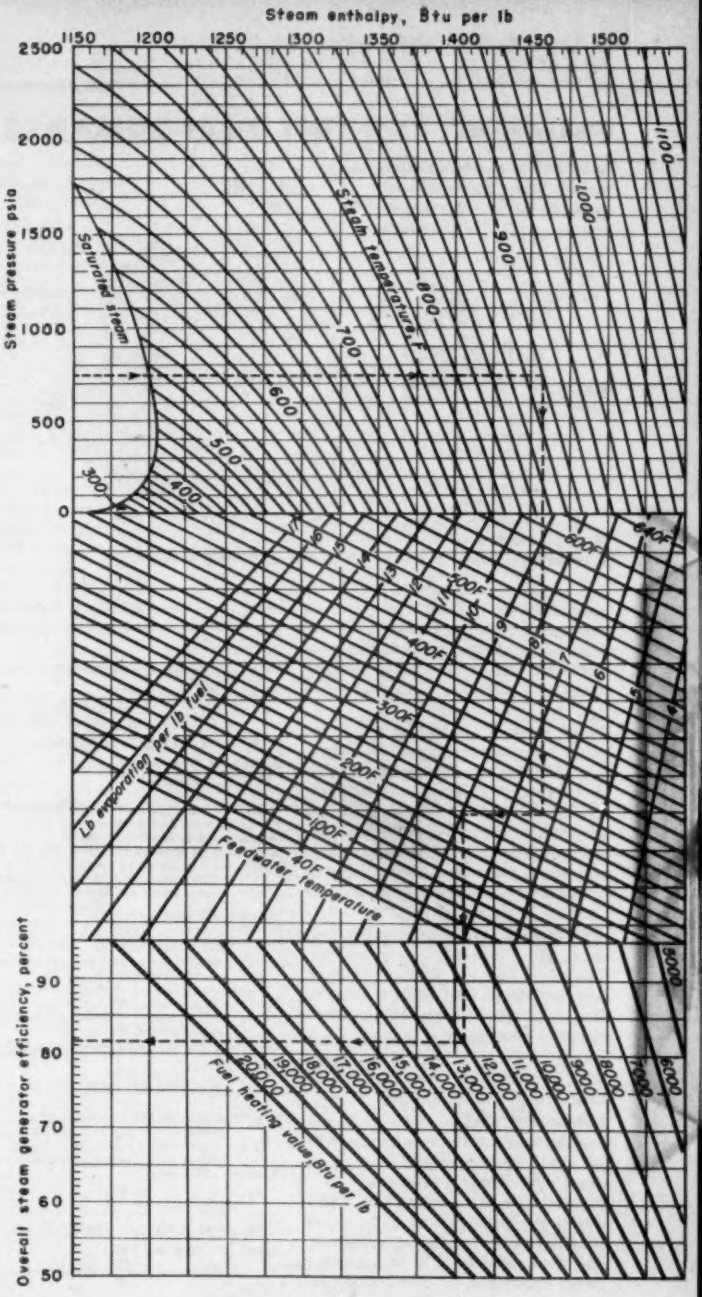
3. *Feedwater temperature.* Hotter feedwater lowers steam temperature because less fuel is fired and less gas passes over superheater.

4. *Fouling.* Fouling of heat-absorbing surfaces ahead of superheater raises steam temperature because furnace gas is hotter. Fouling of superheater lowers steam temperature.

5. *Saturated steam use.* Drawing steam from drum for auxiliaries increases firing rate, raises steam temperature.

6. *Burners and fuel.* Varying number of, or adjusting burners or changing fuel type or characteristics may alter steam temperature.

OVERALL EFFICIENCY. This should be checked daily, weekly or monthly. Use chart at right for quick figuring.



QUICK-FIGURING EFFICIENCY CHART

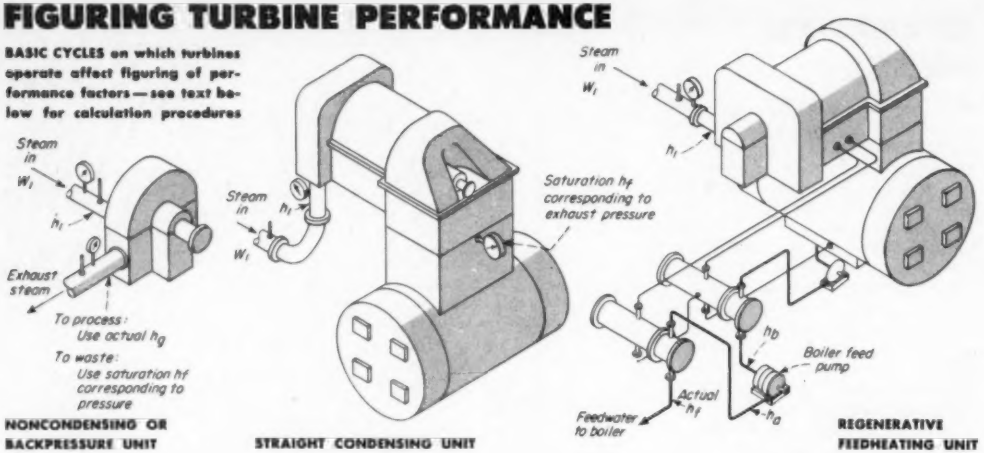
EXAMPLE. In one week a boiler produced 21,500,000 lb of 725-psig 900-F steam and burned 1344 tons of 12,000-Btu-per-lb coal. Feedwater temperature averaged 260 F. Find average weekly overall efficiency.

Average evaporation is 21,500,000 ÷ (1344 x 2000) = 8.0 lb per lb fuel. Absolute steam pressure is 725 + 15 = 740 psia. Enter chart at this pressure, cross to 900 F, down to 260-F feedwater, across to 8. lb evaporation, down to 12,000-Btu fuel and across to 81.8% average overall efficiency.

Compiled by B G A SKROTZKI, Associate Editor

FIGURING TURBINE PERFORMANCE

BASIC CYCLES on which turbines operate affect figuring of performance factors — see text below for calculation procedures



NONCONDENSING OR BACKPRESSURE UNIT | **STRAIGHT CONDENSING UNIT** | **REGENERATIVE FEEDHEATING UNIT**

Turbines convert energy in steam to shaft energy. In selecting and operating them, we're always interested in how effectively this is done. Turbine performance is measured in various ways. Here are common ones:

STEAM RATE is amount of steam required by a turbine to produce a given unit output — usually expressed in lb per kwhr. It is of direct practical concern in figuring boiler steam needs and performance changes of individual turbines. It has only limited value for comparing different turbines because it doesn't reflect changes in throttle pressure, as does heat rate.

HEAT RATE is amount of *energy* to produce a given unit output — usually expressed as Btu per kwhr. Because it deals with basic heat units, it is better than steam rate for comparing turbines.

THERMAL EFFICIENCY is ratio of energy output to energy input. It is directly related to heat rate: thermal efficiency =3413/heat rate. See chart.

ENGINE EFFICIENCY is measure of how well an actual turbine compares with an ideal one. Expanding from given throttle to exhaust conditions, a lb of steam does maximum work if expansion is at constant entropy. This ideal condition is never obtained. When actual work done by a lb of expanding steam is divided by ideal expansion work, the resulting ratio is engine efficiency. It serves as a measure of design effectiveness.

FOR ALL TYPES OF TURBINES:

Steam rate, lb per kwhr

$$= \frac{\text{steam flow, lb per hr } (W_1)}{\text{generator or shaft output, kwhr } (P)}$$

FOR BACKPRESSURE TURBINES:

Heat rate, Btu per kwhr

$$= \frac{W_1 (h_1 - h')}{P}$$

h_1 = steam enthalpy entering turbine, Btu per lb (see diagram)

when steam exhausts to process:

h' = actual exhaust enthalpy, Btu per lb

when steam exhausts to waste:

h' = saturated-water enthalpy at exhaust pressure, Btu per lb (see diagram)

Engine efficiency

$$= \frac{3413\,P}{(W_1 - W_s)(h_1 - h_e) + W_s (h_1 - h_{es})}$$

W_s = steam leaving turbine system from glands and leaks, lb per hr

h_e = exhaust-steam enthalpy at entropy of initial steam, Btu per lb

h_{es} = leakoff steam enthalpy at entropy of initial steam, Btu per lb

FOR STRAIGHT-CONDENSING TURBINES

Heat rate, Btu per kwhr

$$= \frac{(W_1 - W_s)(h_1 - h_f) + W_s (h_1 - h_{fs})}{P}$$

h_f = saturated-water enthalpy at exhaust pressure, Btu per lb (see diagram)

h_{fs} = vaporization enthalpy of leakoff steam at discharge press, Btu per lb

Engine efficiency

$$= \frac{3413\,P}{(W_1 - W_s)(h_1 - h_e) + W_s (h_1 - h_{es})}$$

FOR REGENERATIVE TURBINES:

Heat rate, Btu per kwhr

$$= \frac{W_1 (h_1 - h_f) + (W_1 h_a - h_b)}{P}$$

h_f = enthalpy of feedwater leaving last heater, Btu per lb

h_a = enthalpy of feedwater leaving boiler-feed pump, Btu per lb

h_b = enthalpy of feedwater entering boiler-feed pump, Btu per lb (see diagram)

Engine efficiency

$$= \frac{3413\,P}{W_{b1}(h_1 - h_{sb1}) + W_{b2}(h_1 - h_{sb2}) + \ldots + W_{be}(h_1 - h_{sbe}) + W_e (h_1 - h_{se}) + W_s (h_1 - h_{es})}$$

W_{b1}, W_{b2}, W_{be} = bleed steam flows, lb per hr

h_{sb1}, h_{sb2}, h_{sbe} = enthalpies of bleed steam at initial steam entropy, Btu per lb

W_e = exhaust steam flow, lb per hr

h_{se} = exhaust steam enthalpy at initial steam entropy, Btu per lb

FOR ALL TYPES OF TURBINES:

$$\text{Thermal efficiency} = \frac{3413}{\text{Heat rate, Btu per kwhr}}$$

PERFORMANCE VARIATIONS. Steam rate, heat rate, thermal efficiency and engine efficiency plotted against shaft or generator output in kw show turbine-performance variation with load. Common method for showing performance for automatic-extraction and mixed-pressure turbines plots total hourly steam flow against output for a range of extraction flows.

Turbine performance changes with variations in steam pressure, and temperature, exhaust pressure, makeup-water flow, etc. For methods of figuring corrections for these factors see *Test Code for Steam Turbines*, PTC 6-1949, published by ASME, 29 West 39th St., New York 18, N. Y.

CONVERSION SCALE permits quick transfer from thermal efficiency (percent) to heat rate (Btu per kwhr) for usual range

EXAMPLE

A regenerative turbine produces 11,600 kw at generator terminals when taking 100,000 lb per hr of steam at 800 psia and 900 F, and holding condenser pressure at 1 in. Hg abs. Steam flows and conditions at three bleed points are:

No. 1 — 12,220 lb per hr at 230 psia and 1332 Btu per lb
No. 2 — 9,470 lb per hr at 50 psia and 1210 Btu per lb
No. 3 — 7,400 lb per hr at 7 psia and 1088 Btu per lb

High-pressure gland-leakoff steam goes to No. 1 heater.

Enthalpy of feedwater entering feed pump is 245 Btu. It leaves with 247 Btu per lb. Feedwater temperature leaving last heater is 389F. From steam tables, $h_1 = 1454.9$ Btu, $h_f = 362.7$ Btu. Then

$$\text{Heat rate} = \frac{100{,}000\,(1454.9 - 362.7) + 100{,}000\,(247 - 245)}{11{,}600}$$

$= 9433$ Btu per kwhr

Thermal efficiency $= 3413/9433 = 0.3618$, or 36.18%

Steam rate $= 100{,}000/11{,}600 = 8.62$ lb per kwhr

On chart, *right*, locate h_1 at 800 psia, 900 F; entropy is 1.64. Drop straight down at this entropy to 230 psia where $h_{sb1} = 1300$ Btu. At 50 psia, $h_{sb2} = 1160.6$ Btu, at 7 psia, $h_{sb3} = 1024.7$ Btu, and at 1 in. Hg abs, $h_{se} = 881.3$ Btu. Exhaust steam, $W_e = 100{,}000 - 12{,}220 - 9{,}470 - 7{,}400 = 70{,}910$ lb per hr. Denominator of engine-efficiency equation is $12{,}220\,(1454.9 - 1300.0) + 9470\,(1454.9 - 1160.6) + 7{,}400\,(1454.9 - 1024.7) + 70{,}910\,(1454.9 - 881.3)$. This all equals 48,530,000 Btu per hr, and

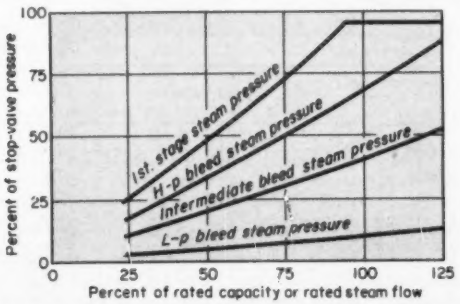
Engine efficiency $= 3413 \times 11{,}600/48{,}530{,}000 = 0.816$, or 81.6%

CONTROLLING OPERATION

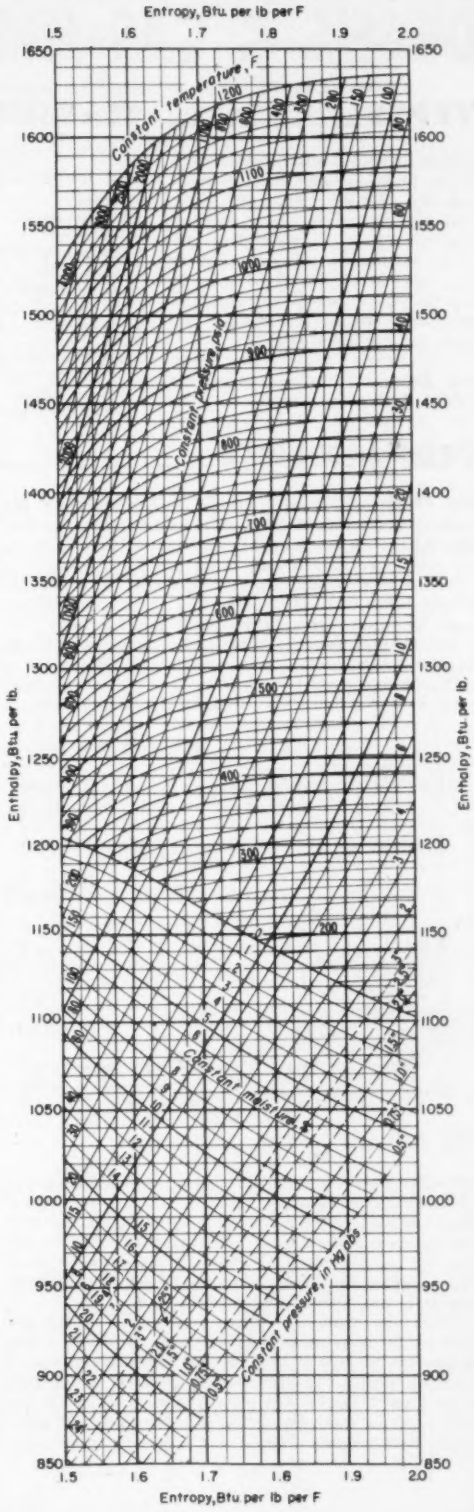
In day-to-day operation, reading steam pressures at various turbine stages, for known loads or flows, serves as a good indicator of internal changes affecting operation.

When turbine is first installed, use properly calibrated operating meters to take data for curves like those below. Then take similar readings at intervals during turbine's operation and compare them with curves. If throttle steam conditions and exhaust pressure vary appreciably, stage pressures must be corrected before comparing with curves. Turbine manufacturers supply such correction data.

As long as steam conditions and internal parts stay the same, pressure readings will fall on the curve lines. If pressures show increasing percentage deviations from these curves with time, deposits are plugging nozzle and blade passages. Sudden changes in pressure readings may be caused by internal damage or change in steam extraction. Check pressure gage and line before opening turbine.



TURBINE CURVES, plotted when machine is new, are watched for deviations that indicate fouling, plugging, blade wear, etc MOLLIER CHART is handy for estimating turbine performance. Section at right is the most-used area of the complete chart →



DIESELS & GAS ENGINES

Compiled by L N ROWLEY, Executive Editor

TYPES

All internal-combustion engines show strong family resemblance – they all burn the fuel-air mixture *inside* the working cylinder. To handle different fuels, and meet various performance needs, however, many special types have been developed. These differ in how the fuel is introduced, when and where fuel and air mix, compression ratio, and method of ignition.

Classification table, *right*, shows these differences. For more details, see POWER, April 1948, p 64, 65.

CLASSIFICATION OF I-C ENGINES

Common designation	Usual fuel	Fuel introduced by	Where and When fuel mixes with air	Comp ratio	Ignition method
Gas engine	Gas	Mixing valve	Outside, before compression	Low[1]	Spark
Injection gas engine	Gas	L–p injection	In cylinder, during compression	Low	Spark
Gasoline engine	Vol liquid	Carburetor	Outside, before compression	Low	Spark
Injection gasoline engine	Vol liquid	H–p injection	In cylinder, before compression	Low	Spark
Hesselman engine	Fuel oil	H–p injection	In cylinder, end of compression	Low	Spark
Vaporizing oil engine	Fuel oil	H–p injection	In cylinder, end of compression	Low	Hot surface
Diesel engine	Fuel oil	H–p injection	In cylinder, end of compression	High	Compression
Gas–diesel engine[2]	Gas	H–p injection	In cylinder, end of compression	High	Pilot oil
Dual–fuel engine[2]	Gas	Induction	Outside, before compression	High	Pilot oil

1 Some modern gas engines employ higher compression pressures: 250–3000 psi instead of 125–150 psi

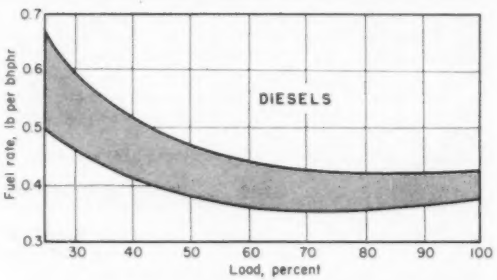
2 By DEMA definition, "gas-diesel" covers both types listed here. "Dual–fuel" engine defined as one which may operate as oil–diesel, gas–diesel, or combination of both and is equipped with controls or parts to permit operating as one or other. Both types burn oil on conventional diesel cycle.

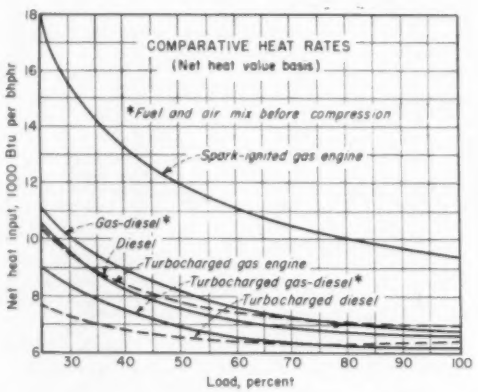
PERFORMANCE

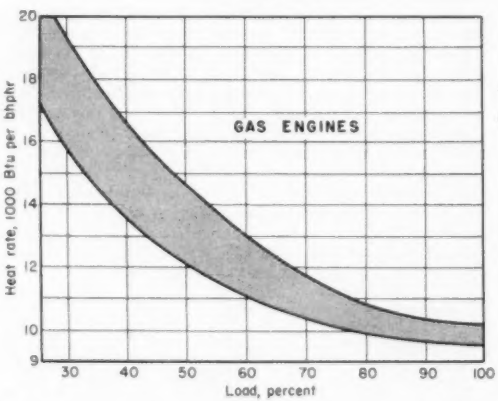
FUEL RATES for oil-burning engines are expressed in lb per brake hphr. Guarantees are based on oil having high (gross) heat value of 19,350 Btu per lb. Chart shows average range. Large low-speed units usually show lowest fuel rates.

Gas-engine performance is expressed in *net* Btu per bhphr, without reference to any specific fuel. Chart gives average range for 4-cycle engines. Ordinary 2-cycle units have full-load heat rates higher than those shown; injection of gas brings 2-cycle performance close to that of 4-cycle.

Chart below shows typical heat rates for various engine types, based, for fair comparison, on one builder's line.

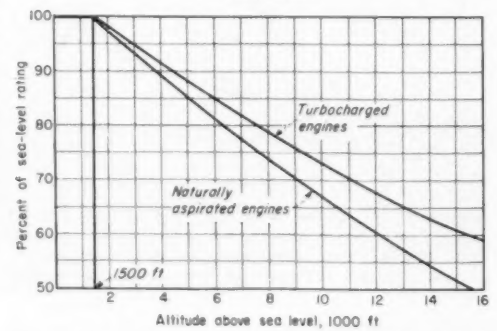






CAPACITY RATING for a diesel engine is net brake hp engine will deliver continuously at an altitude of not over 1500 ft above sea level, with atmospheric temperature not over 90 F and barometric pressure not less than 28.25 in. Hg. At this *standard sea-level rating*, engine will deliver an output of 10% in excess of rating for two out of any 24 hr without exceeding safe operating temperature.

Power any diesel can deliver decreases as altitude increases. To cover most practical cases, sea-level rating applies up to 1500 ft altitude. Net brake hp ratings of nonsupercharged and turbocharged engines at altitudes above 1500 ft, expressed in percent of sea-level rating, appear in curves, *right*. For details on ratings and fuel guarantees, see *Standards of Diesel Engine Manufacturers Assn.*



FACTS ABOUT FUEL OILS & GASES

Properties of Fuel Oil

(Measured at 60 F)

Gravity, degrees API	Specific gravity	Lb per gallon	Btu per lb	Btu per gal	Lb per 42-gal barrel	Weight lb per cubic ft
10	1.0000	8.33	18,540	154,620	350.15	62.36
11	.9930	8.27	18,590	153,740	347.71	61.93
12	.9861	8.22	18,640	153,220	345.28	61.50
13	.9792	8.16	18,690	152,510	342.88	61.07
14	.9725	8.10	18,740	151,790	340.53	60.65
15	.9659	8.05	18,790	151,260	338.22	60.24
16	.9593	7.99	18,840	150,530	335.91	59.83
17	.9529	7.94	18,890	149,980	333.64	59.42
18	.9465	7.89	18,930	149,360	331.42	59.03
19	.9402	7.83	18,980	148,610	329.23	58.64
20	.9340	7.78	19,020	147,980	327.05	58.25
21	.9279	7.73	19,060	147,330	324.91	57.87
22	.9218	7.68	19,110	146,760	322.81	57.49
23	.9159	7.63	19,150	146,110	320.71	57.12
24	.9100	7.58	19,190	145,460	318.65	56.75
25	.9042	7.53	19,230	144,800	316.59	56.39
26	.8984	7.49	19,270	144,330	314.58	56.03
27	.8927	7.44	19,310	143,670	312.60	55.68
28	.8871	7.39	19,350	142,990	310.63	55.32
29	.8816	7.35	19,380	142,440	308.70	54.98
30	.8762	7.30	19,420	141,770	306.81	54.64
31	.8708	7.26	19,450	141,210	304.92	54.31
32	.8654	7.21	19,490	140,520	303.03	53.97
33	.8602	7.17	19,520	139,960	301.18	53.64
34	.8550	7.12	19,560	139,270	299.37	53.32
35	.8498	7.08	19,590	138,690	297.57	53.00
36	.8448	7.04	19,620	138,120	295.80	52.68
37	.8398	7.00	19,650	137,550	294.04	52.37
38	.8348	6.96	19,680	136,970	292.32	52.06
39	.8299	6.92	19,720	136,460	290.64	51.76

Properties of Commercial Fuel Gases

(All data except sewage gas from American Gas Association)

Gas	Constituents of gas – percent by volume									Specific Gravity	Cu ft air per cu ft gas	Btu per cu ft, gross	Btu per cu ft, net	Net Btu per cu ft mixture
	CO_2	O_2	N_2	CO	H_2	CH_4	Illuminants C_2H_4	Illuminants C_3H_6	Illuminants C_4H_8					
Natural gas (Birmingham)	...	...	5.0	...	...	90.0	5.0	...	...	0.60	9.41	1002	904	86.8
Natural gas (Pittsburgh)	...	...	0.8	...	...	83.4	15.8	...	...	0.61	10.58	1129	1021	88.2
Natural gas (So. California)	0.7	...	0.5	...	...	84.0	14.8	...	...	0.64	10.47	1116	1009	88.0
Natural gas (Los Angeles)	6.5	...	...	...	...	77.5	16.0	...	...	0.70	10.05	1073	971	87.9
Natural gas (Kansas City)	0.8	...	8.4	...	...	84.1	6.7	...	...	0.63	9.13	974	879	86.9
Reformed natural gas	1.4	0.2	2.9	9.7	46.6	37.1	...	1.3	...	0.41	5.22	599	536	86.2
Mixed natural and water gas	4.4	2.1	4.7	25.5	35.1	23.1	4.7	0.2	0.2	0.61	4.43	525	477	87.8
Coke-oven gas	2.2	0.8	8.1	6.3	46.5	32.1	...	3.5	0.5	0.44	4.99	574	514	85.8
Coal gas (continuous verticals)	3.0	0.2	4.4	10.9	54.5	24.2	...	1.5	1.3	0.42	4.53	532	477	85.8
Coal gas (inclined retorts)	1.7	0.8	8.1	7.3	49.5	29.2	...	0.4	3.0	0.47	5.23	599	540	86.7
Coal gas (intermittent verticals)	1.7	0.5	8.2	6.9	49.7	29.9	...	3.0	0.1	0.41	4.64	540	482	85.2
Coal gas (horizontal retorts)	2.4	0.75	11.35	7.35	47.95	27.15	...	1.32	1.75	0.47	4.68	547	486	85.6
Mixed coke-oven and carbureted water gas	3.4	0.3	12.0	17.4	36.8	24.9	...	3.7	1.5	0.58	4.71	545	495	86.7
Mixed coal, coke-oven and carbureted water gas	1.8	1.6	13.6	9.0	42.6	28.0	...	2.4	1.0	0.50	4.52	539	475	86.1
Carbureted water gas	3.0	0.5	2.9	34.0	40.5	10.2	...	6.1	2.8	0.63	4.60	550	508	90.8
Carbureted water gas	4.3	0.7	6.5	32.0	34.0	15.5	...	4.7	2.3	0.67	4.51	534	493	89.5
Carbureted water gas (low gravity)	2.8	1.0	5.1	21.0	47.5	15.0	...	5.2	2.4	0.54	4.61	549	501	89.4
Water gas (coke)	5.4	0.7	8.3	37.0	47.3	1.3	...	...	...	0.57	2.10	287	262	84.3
Water gas (bituminous)	5.5	0.9	27.6	28.2	32.5	4.6	...	0.4	0.3	0.70	2.01	261	239	79.6
Oil gas (Pacific Coast)	4.7	0.3	3.6	12.7	48.6	26.3	...	2.7	1.1	0.47	4.73	551	496	86.5
Producer gas (buckwheat anthracite)	8.0	0.1	58.0	23.2	17.7	1.0	...	...	...	0.86	1.06	143	133	65.5
Producer gas (bituminous)	4.5	0.6	50.9	27.0	14.0	3.0	...	...	...	0.86	1.23	163	153	68.6
Producer gas (0.6 lb steam per lb of coke)	6.4	...	52.8	27.1	13.3	0.4	...	...	...	0.88	1.00	135	128	64.0
Blast-furnace gas	11.5	...	60.0	27.5	1.0	...	...	...	...	1.02	0.68	92	92	54.8
Commercial butane	..	..	(C_4H_{10} 93.0)	....	(C_3H_8	7.0)	....	....	....	1.95	30.47	3225	2977	94.6
Commercial propane	..	..	(C_3H_8 100.0)	....	....	....	....	....	....	1.52	23.82	2572	2371	95.5
Sewage gas	34.8	Trace	2.6	....	Trace	62.4	(Trace of H_2S)			0.92	6.0	640	575	82.2

FUEL OIL table above gives exact values for weight and gravity relations. Btu values are necessarily averages but are close enough in most cases.

API degrees, standard of American Petroleum Institute, are generally preferred. For most oils, change of API gravity with temperature is about 0.07 deg for each deg F, with API number rising as temperature goes up. Standard measuring is done at 60 F.

Where oil is delivered at a temperature above or below 60 F, gallonage correction can be figured from API values at actual temperature and at 60 F. But it's easier and just as accurate to figure that volume changes 4 parts per 10,000 for each deg F.

GAS FUEL data appears in table above. Values are typical only. Air needed for a perfect mixture is given; for rough estimating you can figure slightly less than one cu ft for each 100 Btu of gross heat value.

With gas-engine guarantees of heat consumption based on net heat value, divide heat rate by net heat value of gas used to get consumption in cu ft.

Gas-engine output depends mainly on heat value of *mixture* charged in cylinders. Table shows this to vary little except for "lean" gases such as blast-furnace and producer gas.

INTAKE, EXHAUST, JACKET FLOW

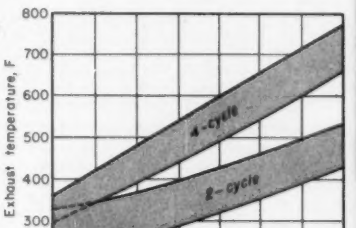
INTAKE air needs for various types of engines are listed, *right*. Weight of exhaust will differ only by fuel weight, small enough to be neglected for rough estimates. Chart gives the range of exhaust temperatures.

Recoverable heat in exhaust (Btu per bhphr) can be approximated roughly by subtracting 300 F from exhaust temperature and multiplying result by weight of exhaust gas (lb per bhphr) and by specific heat (0.24).

AIR REQUIRED BY DIESELS PER RATED BHP

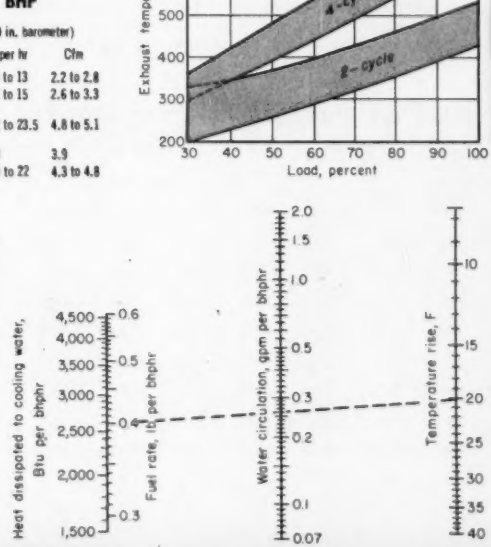
(Dry air at 60 F and 29.9 in. barometer)

Type of engine	Lb per hr	Cfm
4-cycle mech injection	10 to 13	2.2 to 2.8
4-cycle air injection	12 to 15	2.6 to 3.3
2-cycle mech injection, pump scavenging	22 to 23.5	4.8 to 5.1
2-cycle mech injection, crankcase scavenging	18	3.9
2-cycle air injection	20 to 22	4.3 to 4.8



JACKET WATER flow can be found from nomogram, *right*. Enter chart with fuel rate. If not known, assume about 0.4 lb per bhphr, as in example. Draw line to desired temperature rise (20 F in example). Answer is found on middle scale: 0.26 gpm per bhphr. It is usually desirable to hold temperature rise low: 20 F or less.

Second scale at left gives heat dissipation corresponding to a given fuel rate. This is amount of heat (in Btu per bhphr) that must be removed from cooling water if it is recirculated. It is also the amount of heat that may be recovered from the jacket water for hot-water or process heating. Temperature off engine rarely exceeds 180 F.



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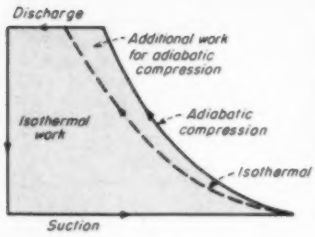
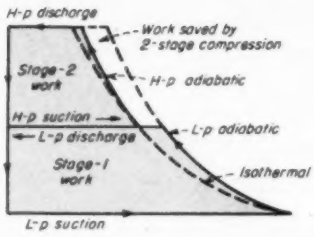
UNDERSTANDING COMPRESSOR PERFORMANCE



ISOTHERMAL compression (no temperature change) is ideal: actual machines approach adiabatic, require more power



TWO-STAGE compression approaches isothermal because intercooler brings air back close to its original temperature

THEORETICAL HP TO COMPRESS 1000 CFM AIR

Final pressure psi abs	Comp ratio	n = 1.4 Single stage	n = 1.4 Two stage	n = 1.3 Single stage	n = 1.3 Two stage	n = 1.2 Single stage	n = 1.2 Two stage	n = 1.0 1 or more stages
30	2.04	51	48	50	47	48	46	45
40	2.72	73	67	71	66	69	65	64
50	3.40	91	85	89	83	85	82	78
60	4.07	110	98	106	97	100	95	89
70	4.76	125	111	119	109	113	106	99
80	5.45	140	121	131	120	124	116	108
90	6.12	151	131	142	128	134	124	116
100	6.80	162	140	153	136	143	131	121
110	7.48	171	147	163	143	150	139	127
120	8.16	181	155	172	151	158	145	133
130	8.85	190	162	180	158	166	152	139
140	9.52	199	169	188	164	173	157	143
150	10.20	207	174	195	169	179	162	148
160	10.88	215	180	202	174	185	168	152
170	11.56	224	185	209	179	190	173	156
180	12.25	232	190	215	184	196	177	159
190	12.91	240	195	221	189	201	181	162
200	13.60	248	200	228	193	207	185	166
210	14.30	256	205	234	197	211	188	169
220	14.95	264	209	239	201	216	192	171

Compression exponent n is 1.0 for isothermal and 1.4 for adiabatic. Suction is 14.7 psi abs. Two-stage compressors based on best receiver pressure and perfect intercooling.

Typical compressor efficiencies based on isothermal compression, include mechanical losses.

Compression ratio	2	3	4	5	6	7	8	9	10
Efficiency single cylinder–percent	68	69	67	64	61	60	59	58	57
Efficiency two stage–percent	..	..	67	68	69	70	69	68	68

COST OF ELECTRICITY TO COMPRESS, DELIVER AIR

(Cents per 100 cu ft free air. Based on 100% motor efficiency)

Bhp per 100 cfm free air	Price of electric current per kwhr, cents: 1	1.5	2	2.5	3	3.5	4	4.5	5
16	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
18	0.225	0.337	0.45	0.562	0.675	0.787	0.9	1.012	1.125
20	0.25	0.375	0.5	0.625	0.75	0.875	1.0	1.125	1.25
22	0.275	0.412	0.55	0.687	0.825	0.962	1.1	1.237	1.375
24	0.3	0.45	0.6	0.75	0.9	1.05	1.2	1.35	1.5
26	0.325	0.487	0.65	0.812	0.975	1.137	1.3	1.46	1.625
28	0.35	0.525	0.7	0.875	1.05	1.225	1.4	1.575	1.75
30	0.375	0.562	0.75	0.937	1.125	1.312	1.5	1.687	1.875

Compressor capacity is usually stated in cu ft per min (cfm) of *free air*. This is air at compressor suction at time being considered. So it isn't always air at 14.7 psia and 60 or 68 F, so called standard atmospheric conditions. Atmospheric pressure decreases 0.1 psi for each 200 ft above sea level up to about 4000 ft. Normal barometric pressure at sea level is 30 in. Hg and decreases 0.1 in. for each 100 ft elevation up to 4000 ft. To convert barometric pressure in in. Hg to psia, multiply by 0.49.

CFM can refer to free air, air at other specified conditions or to piston displacement. *Specific volume* is volume of 1 lb air (cu ft) at given pressure and temperature. *Compressor displacement* is cfm swept out by piston stroke. Use only 1-p piston in multistage compressors. *Volumetric efficiency* is cfm output expressed as a percentage of piston displacement.

ISOTHERMAL compression is ideal—heat of compression is removed so there is no temperature rise. Actual compressors approach *adiabatic* compression—without piston friction, wiredrawing, or loss of heat to jacket.

GENERAL FORMULA for a compression line is $PV^n = constant$. Or absolute pressure times *nth* power of volume is same for all points along line. For isothermal compression, $n = 1$; formula becomes $PV = constant$. Or pressure times volume is same at all points on line. For adiabatic compression, $n = 1.4$. Value of n for actual compression lines lies between 1 and 1.4, usually nearer to 1.4.

TWO-STAGE compression reduces power needs because intercooler brings air back nearly to original temperature. Besides saving power, multistage compression keeps air temperature to safe level even when delivery pressure is high compared to suction. It also improves volumetric efficiency.

In table for theoretical hp, use $n = 1$ or $n = 1.4$ for efficiency studies. To get actual hp needed, divide theoretical hp by over-all efficiency based on $n = 1$ or $n = 1.4$ as case may be.

EXAMPLE: What's free-air capacity (cfm) and weight of air compressed per hr for a compressor at 1500 ft above sea level when sea-level barometer is 29.5 in., inlet temperature 70 F, displacement 1200 cfm, VE=80%?

Solution. Absolute temperature at intake is 70 + 460 = 530. Elevation decreases barometer 0.1 in. per 100 ft, or 1.5 in. So barometer at intake is 29.5 − 1.5 = 28.0. Atmospheric pres-

sure at suction is 28.0 × 0.49 = 13.7 psia. Chart, Part I, p 87, gives specific volume at 13.7 psia and 530 F abs as 14.3 cu ft per lb. Cfm free air is 1200 × 0.80 = 960. Weight free air per min is 960/14.3 = 67.1. Weight in lb per hr is 60 × 67.1 = 4026.

EXAMPLE: What's discharge pressure when we compress air isothermally from normal atmospheric pressure (14.7 psia) to ¼ original volume?

Solution: Volume is ¼ original so pressure is 4 × 14.7 = 58.8 psia or 58.8 − 14.7 = 44.1 psig.

EXAMPLE: About how much power is needed to drive a 2-stage compressor that handles 600 cfm with suction at 14.7 psia, discharge 150 psia?

Solution. Theoretical isothermal power from table is 148 hp for 1000 cfm or 0.6 × 148 = 88.8 hp for 600 cfm. For nearest compression ratio of 10, table gives isothermal efficiency of 68% (over-all). So power at coupling is 88.8/0.68 = 131 hp.

EXAMPLE: What would be approximate power cost for foregoing compressor, with electricity at 3c per kwhr and 90% motor efficiency?

Solution. Bhp per 100 cfm is 131/6 = 22. From power-cost table, cost per 100 cfm at 100% motor efficiency is 0.825c. Total cost at 90% motor efficiency is 0.825 × 6/0.9 = 5.5¢ per min, or 0.055 × 60 = $3.30 per hr.

LUBRICATION, COOLING

Air-cylinder lubrication is plenty important — don't fool with unknown oils or feed rates. Use only well-refined petroleum oils, clean and free of suspended matter and water. With multistage compressors, or where air is extremely moist, oil with small percentage of compounding may be desirable.

Feed rates vary with machine and operating conditions. Table, *below*, lists minimum rates for ideal conditions, as recommended by *Compressed Air and Gas Institute*.

COOLING. You need good water supply for reducing air temperature during compression, between stages and after discharge. Avoid dirty water. Use coldest water in inter- and aftercoolers. Keep cylinder-water discharge temperature in the recommended range. Always fit open funnel or sight-flow indicator to cooling system so you can be sure of flow.

Following table, from *Compressed Air Handbook*, gives recommended cooling flow in gal per 100 cu ft free air.

Intercooler separate	2.5 to 2.8
Intercooler and jackets in series	2.5 to 2.8
Aftercoolers: (1) 80-100 psi, two-stage	1.25
(2) 80-100 psi, single-stage	1.8
Two-stage jackets alone (both)	0.8
Single-stage jackets: (1) 40 psi	0.6
(2) 60 psi	0.8
(3) 80 psi	1.1
(4) 100 psi	1.3

RATE OF OIL FEED FOR COMPRESSOR CYLINDERS

Cylinder diameter, inches	Piston displacement per cylinder, cfm	Swept surface per cylinder, sq ft per min	Oil feed per cylinder	
			Drops per min	Pints per 10 hr*
Up to 6	Up to 65	Up to 500	2 d. in 3 m.	.05
6 to 8	65 to 125	500 to 750	1	.075
8 to 10	125 to 225	750 to 1,100	4 d. in 3 m.	.10
10 to 12	225 to 350	1,100 to 1,500	1–2	.112
12 to 15	350 to 600	1,500 to 2,000	2–3	.188
15 to 18	600 to 1,100	2,000 to 2,600	3–4	.262
18 to 24	1,100 to 1,800	2,600 to 3,600	4–5	.338
24 to 30	1,800 to 3,000	3,600 to 4,800	5–6	.412
30 to 36	3,000 to 4,500	4,800 to 6,000	6–8	.525
36 to 42	4,500 to 6,500	6,000 to 7,500	8–10	.675
42 to 48	6,500 to 9,000	7,500 to 9,000	10–12	.825

* Based on 8,000 drops per pint at 75 F (From Compressed Air Handbook)

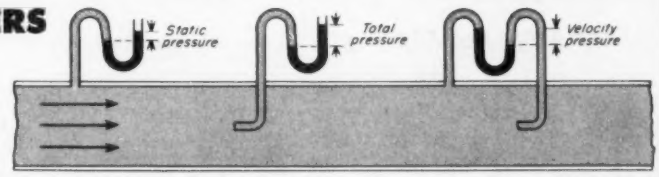
FANS AND BLOWERS

For fans and blowers, pressure differences, being low, are measured in inches of water (1 in. H_2O = 0.0361 psi). *Total* pressure is *static* pressure (against walls of pipe or duct) plus *velocity* pressure (due to energy of motion). Pressure is measured by glass U-tube with water legs. Which pressure is registered (total, static or velocity) depends on way tube is connected, sketches, *right*.

THEORETICAL FAN HP is 0.000158 × cfm × delivery pressure, in. H_2O. This is called *total air horsepower* if total pressure is used; *static air horsepower* if static pressure is used.

EFFICIENCY is output (air hp) divided by input (driving hp). It should be labeled *total* or *static* depending on which air-horsepower value is used. Divide theoretical or air horsepower by appropriate efficiency figure to find actual power needed.

Table, *right*, summarizes outlet velocities and tip speeds for ventilating fans on usual industrial jobs. Where quiet operation is important, as in schools, churches, etc, use lower than average outlet velocity.



PRESSURE MEASUREMENT: U-tube connected at right angles to flow measures static pressure only. With connection facing upstream, total pressure, including velocity head, is registered. To get velocity pressure alone, use both connections as shown

VENTILATING FAN OUTLET VELOCITIES, TIP SPEEDS

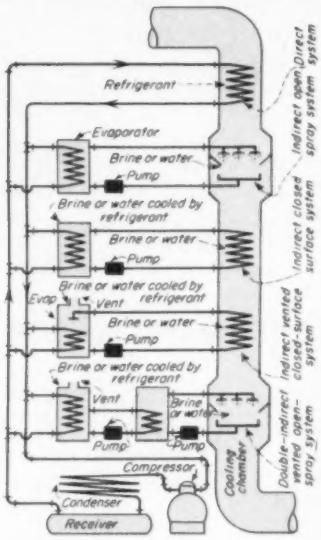
(From *ASH&VE Guide*, 1950)

Static Pressure, Inches of Water	FORWARD CURVED BLADE FANS		BACKWARD TIPPED AND DOUBLE CURVED BLADE FANS		TUBEAXIAL AND VANEAXIAL FANS
	Outlet Velocity Feet per Minute	Tip Speed Feet per Minute	Outlet Velocity Feet per Minute	Tip Speed Feet per Minute	Wheel Velocity* Feet per Minute
1/4	1000–1100	1520–1700	800–1100	2600–3100	1100–1500
3/8	1000–1100	1760–1900	800–1150	3000–3500	1250–1700
1/2	1000–1200	1970–2150	900–1300	3400–4000	1400–1900
5/8	1200–1400	2225–2450	1000–1500	3800–4500	1500–2100
3/4	1300–1500	2480–2700	1100–1650	4200–5000	1650–2350
7/8	1400–1700	2660–2910	1200–1750	4500–5300	1800–2500
1	1500–1800	2820–3120	1200–1900	4800–5750	1900–2700
1-1/4	1600–1900	3162–3450	1300–2100	5300–6350	2150–3000
1-1/2	1800–2100	3480–3810	1400–2300	5750–6950	2350–3300
1-3/4	1900–2200	3760–4205	1500–2500	6200–7550	2500–3550
2	2000–2400	4000–4500	1600–2700	6650–8050	2700–3800
2-1/4	2200–2600	4250–4740	1700–2800	7050–8550	
2-1/2	2300–2600	4475–4970	1800–2950	7450–9000	
3	2500–2800	4900–5365	2000–3200	8200–9850	

*Wheel velocity is axial mean air velocity through inside diameter of housing cylinder at point of wheel location.

Compiled by T G HICKS, Assistant Editor

HOW COLD IS MADE



COMBINED SKETCH shows the five principal classes of refrigeration systems

Most common method of "making cold" is the mechanical or compression refrigeration system. Cooling cycle begins at expansion valve of evaporator where liquid refrigerant expands to a lower pressure, starts to boil and picks up heat from surrounding area.

Refrigerant vapor leaving evaporator is compressed to raise its temperature higher than that of the available cooling-water supply. High-pressure high-temperature gas leaves compressor to pass through condenser. Here lower temperature cooling water removes heat picked up by refrigerant in evaporator, piping and compressor; refrigerant condenses to liquid.

DIRECT AND INDIRECT. A direct cooling system means evaporator is in contact with material or space cooled, or is in air-conditioning passages connected to these spaces. Indirect systems use evaporator to cool brine or water that in turn does the actual cooling.

RATING. Refrigerating capacity is measured in *tons*. One ton of refrigeration means heat removal at the rate of 200 Btu per min, 12,000 Btu per hr or 288,000 Btu per 24 hr.

HEAT LOADS

EXAMPLE: A 20-lb-per-min ammonia system evaporates at 5F, 34.3 psia, compresses to 200F, 170 psia, condenses at 86F. What is capacity in tons, compressor power (80% efficiency), condenser hourly heat load?

Solution. Evaporator refrigerating effect per lb is enthalpy of saturated vapor at 5F, 34.3 psia less that of saturated liquid at 86F, or 613.3—138.9= 474.4 Btu per lb.

Heat of compression is enthalpy at discharge (from superheat table) less that at suction, or 706.9—613.3=93.6 Btu per lb of ammonia.

Heat removed by condenser is enthalpy at discharge less enthalpy of saturated liquid at 86F, or 706.9—138.9=568.0 Btu per lb of ammonia.

Refrigerating capacity, tons, is 20 lb per min×474.4 Btu per lb÷200 Btu per min ton=47.4 tons.

Compressor power is (20 lb per min × 93.6 Btu per lb÷42.4 Btu* per min per hp)÷0.80 efficiency=55.1 hp.

Condensing load is 20 lb per min× 60 min per hr×568.0 Btu per lb= 68,200 Btu per hr.

*Conversion factor from page 74, part one.

REFRIGERANT "HEAT" TABLES

SATURATED AMMONIA

(All values are per lb of refrigerant)

Temp F	psia	psig	Liquid density lb/cu ft	Vapor sp vol cu ft/lb	Enthalpy Sat liquid	Enthalpy Evap	Enthalpy Sat vapor
-40	10.41	8.7*	43.08	24.86	0.0	597.6	597.6
-30	13.90	1.6*	42.65	18.97	10.7	590.7	601.4
-20	18.30	3.6	42.22	14.68	21.4	583.6	605.0
-10	23.74	9.0	41.78	11.50	32.1	576.4	608.5
0	30.43	15.7	41.34	9.116	42.9	568.9	611.8
5	34.27	19.6	41.11	8.150	48.3	565.0	613.3
10	38.51	23.8	40.89	7.304	53.8	561.1	614.9
20	48.21	33.5	40.43	5.910	64.7	553.1	617.8
30	59.76	45.0	39.96	4.825	75.7	544.8	620.5
40	73.32	58.6	39.49	3.971	86.8	536.2	623.0
50	89.19	74.5	39.00	3.294	97.9	527.3	625.2
60	107.6	92.9	38.50	2.751	109.2	518.1	627.3
70	128.8	114.1	38.00	2.312	120.5	508.6	629.1
80	153.0	138.3	37.48	1.955	132.0	498.7	630.7
86	169.2	154.5	37.16	1.772	138.9	492.6	631.5
90	180.6	165.9	36.95	1.661	143.5	488.5	632.0
100	211.9	197.2	36.40	1.419	155.2	477.8	633.0
110	247.0	232.3	35.86	1.217	167.0	466.7	633.7
120	286.4	271.7	35.26	1.047	179.0	455.0	634.0

*Inches of mercury below one standard atmosphere (29.92 in.)

SATURATED FREON-12

Temp F	psia	psig	Liquid density lb/cu ft	Vapor sp vol cu ft/lb	Enthalpy Sat liquid	Enthalpy Evap	Enthalpy Sat vapor
-40	9.317	10.96*	0.01057	3.911	0.00	73.50	73.50
-30	12.02	5.45*	0.0107	3.088	2.00	72.67	74.70
-20	15.28	0.58	0.0108	2.474	4.07	71.80	75.87
-10	19.20	4.50	0.0109	2.003	6.14	70.91	77.05
0	23.87	9.17	0.0110	1.637	8.25	69.96	78.21
5	26.51	11.81	0.0111	1.485	9.32	69.47	78.79
10	29.35	14.65	0.0112	1.351	10.39	68.97	79.36
20	35.75	21.05	0.0113	1.121	12.55	67.94	80.49
30	43.16	28.46	0.0115	0.939	14.76	66.85	81.61
40	51.68	36.98	0.0116	0.792	17.00	65.71	82.71
50	61.39	46.69	0.0118	0.673	19.27	64.51	83.78
60	72.41	57.71	0.0119	0.575	21.57	63.25	84.82
70	84.82	70.12	0.0121	0.493	23.90	61.92	85.82
80	98.76	84.06	0.0123	0.425	26.28	60.52	86.80
86	107.9	93.2	0.0124	0.389	27.72	59.65	87.37
90	114.3	99.6	0.0125	0.368	28.70	59.04	87.74
100	131.6	116.9	0.0127	0.319	31.16	57.46	88.62
110	150.7	136.0	0.0129	0.277	33.65	55.78	89.43
120	171.8	157.1	0.0132	0.240	36.16	53.99	90.15

SUPERHEATED AMMONIA

(V—specific volume; H—enthalpy)

Total temp, F	Absolute pressure, psia (Saturation temperature, F) 20 (-16.64) V	H	30 (-0.57) V	H	40 (11.66) V	H	60 (34.79) V	H	80 (50.29) V	H	100 (62.34) V	H
-10	13.74	610.0	–	–	–	–	–	–	–	–	–	–
0	14.09	615.5	9.250	611.9	–	–	–	–	–	–	–	–
20	14.78	626.4	9.731	623.5	7.203	620.4	–	–	–	–	–	–
40	15.45	637.0	10.20	634.6	7.568	632.1	–	–	–	–	–	–
60	16.12	647.5	10.65	645.5	7.922	643.0	–	–	–	–	–	–
80	16.78	658.0	11.10	656.2	8.268	654.4	5.166	653.8	–	–	–	–
100	17.43	668.5	11.55	666.9	8.609	665.3	5.388	647.8	1.837	641.9	1.520	635.6
150	19.05	694.7	12.65	693.5	9.444	692.3	5.569	679.9	2.081	675.9	1.740	671.8
200	20.66	721.2	13.73	720.3	10.27	719.4	6.830	709.9	2.303	706.9	1.935	703.9
250	–	–	14.81	747.5	11.08	746.8	3.000	739.2	2.514	736.8	2.118	734.5

SUPERHEATED FREON-12

Total temp, F	Absolute pressure, psia (Saturation temperature, F) 20 (-8.2) V	H	40 (25.9) V	H	60 (40.7) V	H	80 (50.4) V	H	120 (104.5) V	H	140 (114.5) V	H	160 (134.5) V	H
20	2.060	81.14	–	–	–	–	–	–	–	–	–	–	–	–
30	2.107	82.55	1.019	81.76	–	–	–	–	–	–	–	–	–	–
40	2.155	83.97	1.044	83.20	–	–	–	–	–	–	–	–	–	–
50	2.203	85.40	1.070	84.65	0.690	83.83	–	–	–	–	–	–	–	–
60	2.250	86.85	1.095	86.11	0.708	85.33	–	–	–	–	–	–	–	–
80	2.343	89.78	1.144	89.09	0.743	88.35	–	–	–	–	–	–	–	–
100	2.437	92.75	1.194	92.09	0.778	91.41	0.557	89.13	–	–	–	–	–	–
120	2.530	95.78	1.242	95.15	0.812	94.51	0.577	92.38	0.314	91.60	0.264	90.68
140	2.623	98.85	1.291	98.26	0.846	97.65	0.597	95.65	0.332	94.96	0.282	94.12
160	2.716	101.97	1.340	101.42	0.880	100.84	0.617	98.96	0.350	98.34	0.298	97.57

PROPERTIES OF COMMON REFRIGERANTS

(Thermodynamic properties based on standard-ton conditions: evaporation at 5 F and condensation at 86 F)

NAME OF REFRIGERANT	Chemical symbol (1)	Evaporator temperature range (2)	Boiling point, F (atmospheric)	Freezing point, F (atmospheric)	Critical temp, F	Condensing (head) pressure, at 86 F, psi gage (3)	Evaporation (suction) pressure at 5 F, psi gage (3)	Net refrig effect, (86 F to 5 F), Btu per lb	Refrigerant flow, (86 F to 5 F) lb per min per ton	Liquid refrig flow (86 F to 5 F) cu in. per min per ton	Compressor displ (5 F) cu in. per min per ton (5 F) cfm per ton	Type of compressor (4)	Condenser cooling	Safety code group (5)	Low-side min test press, psi gage (6)	High-side min test press, psi gage (6)	Concentration in air to form flammable or explosive mix, % by volume (7)	Exposure time, hr.	% by volume concentration	Lb per 1000 cu ft of air	Mix with Lube oil?	Odor (8)	Special hazards (9)
Ammonia	NH_3	L–H	−28.0	−107.9	271.2	154.5	19.6	474.6	0.421	19.6	3.46	Rec	Water	2	150	300	16–25	1/2	0.5	0.25	No	Yes	With moisture attacks copper and alloys, some galvanized surfaces. Spoils foods
Carbon dioxide	CO_2	L, M	−109.3	−69.9	87.8	1028.3	316.8	55.5	3.65	167.0	0.96	Rec	Water	1	1000	1500	N	1/2–1	29	33	No	No	
Dielene	$C_2H_4Cl_2$	H	118.0	−70.0	470.0	15.8*	20.3*	114.3	1.75	30.3	111.2	Cen	Water	2	30	30	5.6–11.4 D	1	2	9	Yes	Weak	Corrosive to iron and steel if moisture and air are present
Ethyl chloride	C_2H_5Cl	M, H	54.5	−217.7	369.0	12.4	20.5*	142.3	1.41	44.4	22.62	Rot.	Air	2	50	60	3.7–12 D	1	4	7	Yes	Yes	With moisture forms hydrochloric acid
Freon–11	CCl_3F	H	74.7	−168.0	388.4	3.6	24.8*	67.5	2.96	56.0	36.3	Rot. Cen	Water	1	30	30	N, D	2	10	35	Yes	No	
Freon–12	CCl_2F_2	M, H	−21.6	−247.0	233.0	93.2	11.8	51.1	3.91	83.0	5.81	Rec-Rot.	W or A	1	140	235	N, D	2	28	90	Yes	No	Attack magnesium. With moisture form hydrochloric acid to attack most metals, attack natural rubber; harmless to food
Freon–21	$CHCl_2F$	M, H	48.0	−211.0	353.3	16.5	19.5*	89.4	2.24	45.0	20.46	Rot.	Air	1	40	70	N	1/2	10	27	Yes	No	
Freon–22	$CHClF_2$	U, L	−41.4	−256.0	204.8	169.9	26.3	69.3	2.89	68.1	3.60	Rec	Water	1	150	300	N, D	—	—	—	Yes	No	
Freon–113	$C_2Cl_3F_3$	H	117.6	−31.0	417.4	13.5*	27.9*	53.7	3.73	66.4	106.9	Cen	Water	1	30	30	N, D	1	5	23	Yes	No	
Freon–114	$C_2Cl_2F_4$	M, H	38.4	−137.0	294.3	32.0	16.1*	43.1	4.64	89.3	19.59	Rot.	Air	1	50	50	N, D	2	20	90	Yes	No	Same as Freons, also attacks zinc, aluminum; may flavor foods but does no harm
Isobutane	$(CH_3)_2CH$	M, H	10.3	−229.0	272.7	44.8	3.3*	111.5	1.79	91.1	11.50	Rec-Rot.	W or A	3	70	130	1.8–8.4	—	—	—	Yes	Weak	
Methyl chloride	CH_3Cl	M, H	−10.8	−144.0	289.4	80.0	6.5	150.2	1.33	49.9	5.95	Rec-Rot.	W or A	2	120	210	8.1–17.2 D	2	2	2.5	Yes	Weak	Same as ethyl chloride
Methylene chloride	CH_2Cl_2	H	103.6	−142.0	421.0	8.4*	27.4*	134.6	1.49	30.9	74.3	Cen	Water	1	30	30	N, D	1/2	5	11	Yes	Weak	
Sulfur dioxide	SO_2	M, H	14.0	−103.9	314.8	51.8	5.9*	142.8	1.40	28.6	9.10	Rec-Rot.	W or A	2	85	170	N	5 min	0.7	1.2	No	Yes	With moisture forms sulfurous acid, attacks most metals. Withers flowers, will bleach some dyes. Won't harm food (acts as preservative
Water (40 F & 86 F)	H_2O	H	212.0	32.0	706.1	28.7*	29.7*	1025.3	0.195	5.4	474.6	Cen-Jet	Water	—	—	—	N	—	—	—	No	No	

(1) N–Nitrogen, H–Hydrogen, C–Carbon, Cl–Chlorine, F–Fluorine, S–Sulfur (2) U–Ultra-low: −130 to −75 F, L–Low: −75 to 0 F, M–Medium: 0 to 30 F, H–High: over 30 F, (3)*Inches of mercury vacuum, (4)Rec–Reciprocating, Cen–Centrifugal, Rot.–Rotary, (5) ASRE Std 15-R: 1–Used generally with minor limitations, 2–Used generally with strict limitations, 3–Prohibited in all but industrial occupancies (and commercial laboratories in unit systems containing not over 6 lb); see Standard for exact limitations for all refrigerants. (6) From ASRE Std 15-R: (7) N–non-flammable, except slightly flammable Freon-21; D–Decomposition products from heat of flame are highly toxic. (8) Decomposition products of Freons, etc, have pungent odors, (9) Moisture in refrigerants can cause freezing of expansion valve. With all refrigerants, be sure to use proper lubricants, gasket materials, etc, as unusual combinations of refrigerant, lube and piping material (with/without moisture/air) may produce undesirable chemical reactions.

OPERATING HINTS

POWER NEEDED. Except for CO_2 systems, general rule for rating refrigeration systems is one to two horsepower per ton of refrigeration. Table, right, gives theoretical hp for ammonia at different suction, discharge pressures; add 30 to 50% for actual horsepower.

PRESSURES. Reducing suction pressure lowers evaporation temperature but it also means more power is needed per ton of refrigeration and compressor capacity falls off because vapor is lighter and piston displaces less weight per stroke. Raising head pressure raises discharge temperature and more power is needed per ton of refrigeration. To reduce power input and conserve capacity keep head pressure as low as possible and suction pressure as high as needed to produce the desired evaporator temperature.

CONDENSER COOLING. Air-cooled condensers need about 800 to 1000 cfm per ton. Water-cooled units take 1.5 to 4 gpm per ton, depending on source of water. With water from city mains, 1.5 gpm per ton gives about 20-deg-F rise through condenser. With well water, 2 to 3 gpm gives about 10-deg-F rise through condenser. With atmospheric cooling tower, for about a 7.5-deg-F rise, use 3 to 4 gpm per ton, depending on distance of tower from condenser. For forced- or induced-draft towers, use 2 to 2.5 gpm per ton with 300 to 400 cfm of air per ton.

LUBRICATION. Lubricant depends on compressor design, refrigerant and operating conditions. Selection of lubricant should be made by manufacturer. Table above gives viscosity ranges of lubricants commonly used.

HP PER TON OF REFRIGERATION: AMMONIA

(Theoretical; divide by overall efficiency for true hp)

Suction pressure and corresponding temp		Condenser pressures, psi gage, and corresponding temperatures F							
Psi gage	F	103 (65 F)	115 (70 F)	127 (75 F)	139 (80 F)	153 (85 F)	168 (90 F)	184 (95 F)	200 (100 F)	218 (105 F)
6	−15	0.997	1.069	1.145	1.222	1.3000	1.410	1.461	1.546	1.630
9	−10	0.903	0.978	1.045	1.118	1.193	1.260	1.347	1.435	1.509
13	−5	0.818	0.883	0.954	1.023	1.094	1.168	1.244	1.321	1.396
16	0	0.735	0.801	0.865	0.933	1.002	1.072	1.147	1.219	1.255
20	5	0.666	0.731	0.795	0.859	0.928	0.998	1.066	1.138	1.212
24	10	0.592	0.643	0.726	0.789	0.854	0.921	0.991	1.060	1.129
28	15	0.541	0.600	0.664	0.728	0.792	0.855	0.922	0.994	1.060
33	20	0.474	0.534	0.592	0.672	0.715	0.780	0.842	0.903	0.974
39	25	0.410	4.466	0.523	0.580	0.599	0.702	0.767	0.829	0.892
45	30	0.351	0.406	0.461	0.518	0.576	0.635	0.694	0.759	0.817

RECOMMENDED LUBRICANT VISCOSITY RANGES

(From ASRE Data Book, 1949)

	Recommended Viscosity ranges
SMALL SYSTEMS (Rec–Reciprocating compressor, Rot.–Rotary, Cen–Centrifugal)	
Rec: Carbon dioxide, methyl chloride, Freon-12, 21; Rot: Freon-114, sulfur dioxide; Cen: Methylene chloride, Freon-11, 12, 113	200-300 SSU at 100 F
Rec: Ammonia; Rot: Methylene chloride	150-300 SSU at 100 F
Sulfur dioxide (Rec)	70-200 SSU at 100 F
INDUSTRIAL REFRIGERATION (Ammonia and carbon-dioxide compressors)	
Where oil may enter refrigeration system or compressor cylinders	150-300 SSU at 100 F
Where oil is prevented from entering system or cylinders: (1) in force-feed or gravity systems	500-600 SSU at 100 F
(2) in splash systems	150-160 SSU at 100 F
Steam-driven compressor cylinders when condensate is reclaimed for ice making	140-165 SSU at 210 F
MISCELLANEOUS EQUIPMENT	
Bearings: (1) ring oiled, normal temperature	200-300 SSU at 100 F
(2) ring oiled, low temperature	100-115 SSU at 100 F
(3) chain oiled	280-300 SSU at 100 F
Ball and roller bearings, oil lubricated	280-300 SSU at 100 F
Wick oilers	200-600 SSU at 100 F

BRINES

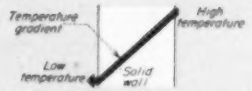
CALCIUM CHLORIDE

Density of brine of 60 F				Pounds 73–75% solid calcium chloride	
Specific gravity	Baume scale	Percent anhydrous calcium chloride	Freezing point F	Per gal solution at 60 F	Per cu ft solution at 60 F
1.00	1.0	0.0	32.0	.00	0.0
1.04	5.6	4.7	28.0	.55	4.1
1.08	10.7	9.2	23.4	1.13	8.4
1.10	13.2	11.4	20.3	1.42	10.6
1.12	15.5	13.5	16.5	1.70	12.8
1.14	17.8	15.6	12.0	2.00	15.0
1.16	20.0	17.6	7.0	2.30	17.2
1.18	22.1	19.5	1.4	2.60	19.4
1.20	24.2	21.5	− 5.8	2.90	21.7
1.22	26.2	23.3	−13.2	3.20	24.0
1.24	28.1	25.1	−21.3	3.51	26.2
1.26	29.9	26.9	−30.0	3.83	28.6
1.28	31.7	28.7	−44.1	4.14	31.0
1.29	32.6	29.6	−55.0	4.31	32.2

Brines are used to carry heat from cooled region to evaporator. These brines are nothing more than water to which a salt has been added to lower freezing temperature. Calcium chloride and sodium chloride brines are the most common. Calcium chloride is suitable for lower temperatures than sodium chloride. In plants that operate continuously, about 60 cu ft of brine per ton of refrigeration is needed. Brine circulating pump size is figured in same manner as a water pump. Brine weight is about 62.5 times the specific gravity of the brine at 60F.

Compiled by J C McCABE, Associate Editor

HOW HEAT FLOWS THROUGH WALLS



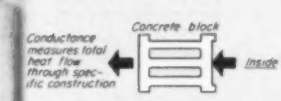
Heat flow through a uniform solid wall depends on temperature difference from inside to outside, material, thickness

Heat flowing to and from actual walls meets resistances. Thus there are temperature gradients between air and wall

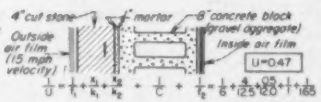
Larger air-film temperature drop, lower surface temperature
Glass
Insulating board
Smaller air-film temperature drop, higher surface temperature

With low-resistance glass, temperature drops in air films bulk large; with an insulator, they become less important

Air space in a wall introduces temperature drops between internal surfaces of wall and the air in the space between



For homogeneous materials, conductivity is given per inch thickness; for others conductance for total thickness is used



Reciprocal of over-all heat transmission coefficient, U, for builtup walls is sum of individual-conductance reciprocals

Rate of heat flow through a barrier depends on temperature difference across it, nature of material and thickness. Measure of heat-transfer ability is *conductivity*, k – Btu/hr/sq ft/deg F/in. thickness. Rate of heat flow through a given thickness is *conductance*, C – Btu/hr/sq ft/ deg F. Conductance equals conductivity *divided* by thickness. Rate at which temperature falls from one side to the other is called *temperature gradient*.

SURFACE CONDUCTANCE. Heat flow *to* and *from* a wall (not through it) is a complicated process. In practice it is summed up as *surface conductance*, f. This is Btu/hr transmitted to or from one sq ft for one deg F temperature difference between air and surface. Rougher surfaces, higher air velocities mean higher f. Inside f (still air) is taken as 1.65 and outside (15 mph air velocity) as 6.0.

SURFACE TEMPERATURES. Importance of surface conductances depends on other resistances. Single pane of glass (sketch) offers little resistance, so surface conductances are most important part of total. Big inside temperature

CONDUCTIVITIES, CONDUCTANCES, COEFFICIENTS (Selected from ASH&VE Guide)

CONDUCTIVITIES OF BUILDING MATERIALS

FUNCTION	MATERIAL	DESCRIPTION	CONDUCTIVITY*	RESISTANCE
AIR SPACES	Bounded by plain surfaces	Vertical, 3/4 in. or more in width	1.10 (C)	0.91 (1/C)
	Bounded by aluminum foil	Vertical, 3/4 in. or more in width	0.46 (C)	2.17 (1/C)
INSULATING MATERIALS	Bats and Blankets	Mineral, vegetable fiber, animal hair	0.27 (K)	3.70 (1/K)
	Cardboard	Pure, no added binder	0.30 (K)	3.33 (1/K)
	Insulating Board	Vegetable fiber	0.33 (K)	3.03 (1/K)
	Mineral Wool	Fiber made from rock, slag or glass	0.27 (K)	3.70 (1/K)
INTERIOR FINISHES	Composition Wallboard	3/16 in. to 3/8 in. thick	0.50 (K)	2.00 (1/K)
	Gypsum plaster		3.30 (K)	0.30 (1/K)
	Gypsum board (3/8 in.)		3.70 (C)	0.27 (1/C)
	Insulating board (1/2 in.)	Plain or decorated	0.66 (C)	1.52 (1/C)
	Metal lath and plaster	Plaster thickness assumed 3/4 in.	4.40 (C)	0.23 (1/C)
	Plywood (3/8 in.)	Plain or decorated	2.12 (C)	0.47 (1/C)
MASONRY MATERIALS	Brick	Common, assumed 4 in. thick	1.25 (C)	0.80 (1/C)
	Brick	Face, assumed 4 in. thick	2.30 (C)	0.43 (1/C)
	Cement Mortar		12.00 (K)	0.08 (1/K)
	8 in. clay tile (hollow)		0.60 (C)	1.67 (1/C)
	12 in. clay tile (hollow)		0.40 (C)	2.50 (1/C)
	Concrete	Light weight aggregate	2.50 (K)	0.40 (1/K)
	Concrete	Sand and gravel aggregate	12.00 (K)	0.08 (1/K)
	8 in. concrete blocks	Hollow, gravel aggregate	1.00 (C)	1.00 (1/C)
	12 in. concrete blocks	Hollow, gravel aggregate	0.80 (C)	1.25 (1/C)
	8 in. concrete blocks	Hollow, cinder aggregate	0.60 (C)	1.66 (1/C)
	12 in. concrete blocks	Hollow, cinder aggregate	0.53 (C)	1.88 (1/C)
	8 in. concrete blocks	Hollow, light weight aggregate	0.50 (C)	2.00 (1/C)
	12 in. concrete blocks	Hollow, light weight aggregate	0.47 (C)	2.13 (1/C)
	Gypsum fiber concrete	87-1/2% gypsum and 12-1/2% wood chips	1.66 (K)	0.60 (1/K)
	Stone		12.50 (K)	0.08 (1/K)
ROOFING MATERIALS	Built-up roofing	Assumed thickness 3/8 in.	3.53 (C)	0.28 (1/C)
	Heavy roll roofing		6.50 (C)	0.15 (1/C)
	Slate	Assumed 1/2 in.	20.00 (C)	0.05 (1/C)
SHEATHING	Gypsum (1/2 in.)		2.12 (C)	0.35 (1/C)
	Insulating board (25/32 in.)		0.42 (C)	2.37 (1/C)
	Plywood (5/16 in.)		2.56 (C)	0.39 (1/C)
	Fir, plus building paper	Actual thickness 25/32 in.	0.86 (C)	1.16 (1/C)
SURFACES	Still air	Non-reflective materials, vertical	1.65 (C)	0.61 (1/C)
	15 mph wind velocity	Non-reflective materials, vertical	6.00 (C)	0.17 (1/C)
WOODS	Maple or oak		1.15 (K)	0.87(1/K)
	Yellow pine or fir		0.80 (K)	1.25 (1/K)

*Btu/hr/sq ft/deg F – conductivities (K) are per inch thickness and conductances (C) are for thickness or construction stated, not per inch thickness.

COEFFICIENTS OF BUILTUP CONSTRUCTIONS

MASONRY WALLS	Thickness of masonry or backing	Plain walls (no finish)	Plaster (1/2 in.) on walls	Metal lath, plaster furred	Insulating board (1/2 in.) furred
Solid brick	12 in.	0.36	0.34	0.25	0.19
Poured concrete	12 in.	0.57	0.53	0.35	0.24
Hollow concrete blocks					
gravel aggregate	12 in.	0.49	0.46	0.32	0.22
cinder aggregate	12 in.	0.38	0.36	0.26	0.20
lightweight aggregate	12 in.	0.34	0.33	0.25	0.19
Brick veneer (4 in.) plus					
.. concrete backing	8 in.	0.54	0.50	0.33	0.23
.. concrete blocks					
gravel aggregate	8 in.	0.44	0.41	0.29	0.21
cinder aggregate	8 in.	0.34	0.33	0.25	0.19
lt-wgt. aggregate	8 in.	0.31	0.29	0.23	0.18
Cut-stone veneer (4 in.) plus					
.. concrete backing	8 in.	0.57	0.53	0.35	0.24
.. concrete blocks					
gravel aggregate	8 in.	0.47	0.44	0.30	0.22
cinder aggregate	8 in.	0.36	0.34	0.25	0.19
lt-wgt. aggregate	8 in.	0.32	0.30	0.23	0.18

CONCRETE CEILINGS AND FLOORS	Thickness of concrete	No flooring	Tile or terrazo	Asphalt tile (1/8 in.)	Double wood floor
No ceiling	6 in.	0.59	0.56	0.58	0.23
1/2 in. plaster under ceiling	6 in.	0.54	0.52	0.53	0.22
Metal lath, plaster ceiling	6 in.	0.35	0.34	0.35	0.18

BUILT-UP FLAT ROOFS	Thickness of roof deck	No insulation	Insulation atop deck (covered with roofing) Insulating board 1/2 in.	Insulating board 1 in.	Corkboard 1 in.	Corkboard 2 in.
Metal (no ceiling)	....	1.06	0.39	0.24	0.23	0.13
Metal (lath, plaster ceiling)	....	0.46	0.27	0.19	0.18	0.11
Concrete (no ceiling)	4 in.	0.72	0.34	0.23	0.21	0.12
Concrete (lath, plaster ceiling)	4 in.	0.40	0.25	0.18	0.17	0.11

SOLID WOOD DOORS	Nominal thickness	Actual	Exposed door	With storm door
	1 in.	25/32 in.	0.69	0.42
(For doors with thin panels use	2 in.	1 5/8 in.	0.46	0.32
coefficient 1.13)	3 in.	2 5/8 in.	0.33	0.25

HOLLOW GLASS BLOCK WALLS (7 3/4 x 7 3/4 x 3 7/8)	Still air on both sides	Still air inside, 15 mph out
Smooth surface	0.40	0.49
Ribbed surface	0.38	0.46

WINDOWS, SKYLIGHTS	
single	1.13
double	0.45
triple	0.28

drop means inside glass surface is cold. But with a thin insulating board surface effects are less important, inside wall surface is warmer.

Air spaces, if more than about 1½ in. wide, introduce additional surface conductances. For narrow spaces, a single coefficient is usually used.

OVER-ALL COEFFICIENTS. For homogeneous materials, conductivity *k*, divided by thickness in inches, gives conductance C. Table lists typical values. Conductivity can't be given for non-uniform materials or complex shapes like hollow tile. So table lists conductance for specific types and sizes.

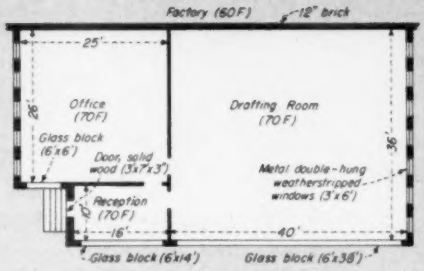
For builtup constructions met in practice, over-all coefficient *U* (Btu/hr/sq ft/deg F) is used. Reciprocal of *U* equals sum of reciprocals of individual conductances of each element, including surface conductances. Sketch, *left*, shows this in formula form for a typical masonry wall. Table below lists reciprocals of conductivities and conductances to make figuring easier. To get reciprocal of conductance when you have reciprocal of conductivity, *multiply* by thickness.

CONSTRUCTION DATA

Office bldg walls: 4-in. brick veneer, 8-in. concrete, ½-in. plaster. Roof: flat metal deck, 1-in. insulating board, lath and plaster ceiling, 10-ft ceiling height. Floor: 6-in. concrete, ⅛-in. asphalt tile. Factory wall: 12-in. brick.

WEATHER DATA

Design temperature: 0 F. Average wind velocity: 17 mph



EXAMPLE OF ESTIMATING HEAT LOAD AND FUEL CONSUMPTION

Source of heat loss	Calculation of gross areas and crack lengths	Net area or crack length	Coeff	Temp diff, F	Design heat loss, Btu/hr	Total heat loss each space, Btu/hr	Estimate of fuel consumption based on degree-day method
Reception:							Basic formula: $F = UxNxD$ where F = fuel use for estimate period; U = unit fuel use per degree-day per heat-load unit; N = number of heat-load units; D = number degree-days.
Walls	(16x10)+(10x8)=240	240-21-84=135	0.50	10	3425		Calculation of U will for table below:
Door	3x7=21	21	0.33	70	485		$U = 0.00409$ per 1000 Btu heat loss for oil at 70% efficiency, and for 70 F inside, 0 F outside (design) with 8 hr reduction to 55 F (from Guide)
Glass block	6x14=84	84	0.46	70	2710		
Infiltration	3+3+7+7=20	20	0.58[a]	70	813		
Roof	16x10=160	160	0.19	70	2080		$N = 118,818/1000 = 118.8$
Floor	16x10=160	160	0.58	15 [b]	1390	12,953	$U \times N = 0.00409 \times 118.8 = 0.49$
Office:							
Walls (outside)	(40x26)+(10x8)=1040	1040-90-36=914	0.50	70	7500		
Wall (factory)	10x25=250	250	0.36	10	900		
Windows	5(3x6)=90	90	1.13	70	7130		
Glass block	6x6=36	36	0.46	70	1160		
Infiltration	5(3+3+3+6+6)=105	105	0.58[a]	70	4270		
Roof	26x25=650	650	0.19	70	8650		
Floor	26x25=650	650	0.58	15 [b]	5655	35,265	
Drafting Rm.							
Walls (outside)	(40x16)+(26x8)=760	760-198-228=334	0.50	70	14210		
Wall (factory)	40x10=400	400	0.36	10	1440		
Windows	7(3x6)=126	126	1.13	70	9970		
Glass block	6x38=228	228	0.46	70	7340		
Infiltration	7(3+3+3+6+6)=147	147	0.58[a]	90	5930		
Roof	40x36=1440	1440	0.19	70	19150		
Floor	40x36=1440	1440	0.58	15 [b]	12330	76,600	
Total						118,818	

Month	Deg days	U x N	Fuel oil, gal
Oct	272	0.49	133
Nov	594	"	290
Dec	940	"	461
Jan	1088	"	534
Feb	953	"	467
March	771	"	378
April	455	"	223
May	172	"	84
			2447

NOTES: [a] Infiltration coefficient = 32 cu ft/hr/ft crack x 0.075 lb/cu ft x 0.24 Btu/lb/deg F = 0.58 Btu/hr/ft crack/deg F. [b] Ground temperature taken as 55 F.

FIGURING HEATING LOADS

While figuring building heat loads takes the experienced judgment of a specialist, every power engineer should know how it's done. Then you can make rough estimates, check proposals.

EXAMPLE. Start by tabulating surfaces through which heat flows. Form like one above makes job easier. Work room by room so you'll get loads for individual spaces. Areas of similar construction and working against same temperature difference can be totaled. Easiest way to handle walls with windows, etc, is to add total glass area first, then subtract from wall area.

COEFFICIENTS. Over-all coefficients are given in *ASH&VE Guide;* typical values are extracted in table, *left*. For constructions not listed, figure as described above. Most coefficients are based on 15-mph wind velocity, good enough for most cases. For high wind velocities, figure special coefficients or increase heat loss by an arbitrary "exposure factor"—say 15%.

INFILTRATION. Wind pressure and inside-outside temperature difference cause air to leak into or out of buildings around doors, windows, other construction cracks. This *infiltration* may be allowed for by assuming a certain number of *air changes* per hr, based on nature of construction and occupancy. More accurate method measures crack length in linear ft and multiplies by appropriate value for cu ft of air per ft of crack per hr.

Infiltration coefficient is figured thus: *Guide* gives air leakage per ft of crack for weatherstripped metal double-hung windows as 32 cu ft/hr at 15-mph air velocity. This is converted to Btu/hr/ft crack by multiplying by 0.075 (density of air) and 0.24 (specific heat of air). See example.

DESIGN CALCULATION. To figure *design* heat loss, outside temperature is usually taken as 10-15 F above locality's lowest recorded temperature. Ground temperature is taken as well-water temperature 30-60 ft down. For walls between two parts of a building, use actual difference, if any. Inside temperature depends on occupancy (here 70 F in office, 60 F in factory).

Total heat loss serves to figure boiler size, etc. Heat loss from individual spaces is used for laying out heat-distribution system. Load is often expressed in units of heat delivery, EDR (equivalent direct radiation). Dividing heat loss by 240 gives EDR for steam, by 150 EDR for hot water.

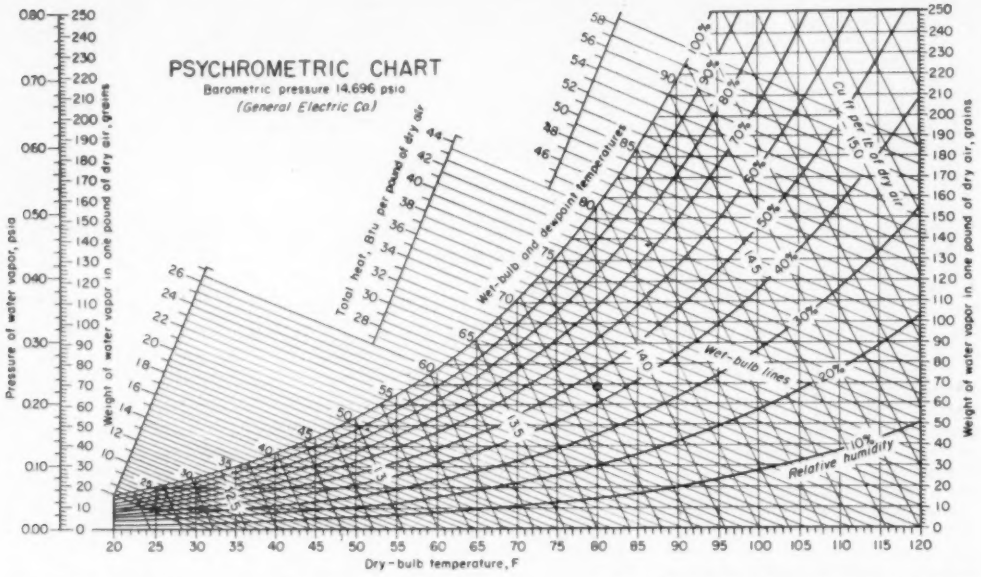
FUEL CONSUMPTION can be figured by heat-loss calculation using average outside temperature during heat season, instead of design temperature. This gives average hourly heat loss which can be multiplied by hours and then converted into fuel needs.

Today most such calculations are made by the *degree-day method*. Experience shows that heat loss from a building held at 70 F varies with number of degrees difference between average outside temperature and 65 F. For example, if outside temperature averages 55 F for 24 hr we have 65—55=10 *degree days*. Degree-day figures are published for major cities annually.

For various fuels and efficiencies, factors have been worked out to give unit fuel use per degree day per heat-load unit. To figure fuel consumption, multiply factor by degree days per month or season times heat-load units (design loss in thousands of Btu/hr).

AIR CONDITIONING

Compiled by J C McCABE, Associate Editor


PSYCHROMETRIC CHART
Barometric pressure 14.696 psia
(General Electric Co.)
Pressure of water vapor, psia
Weight of water vapor in one pound of dry air, grains
Total heat, Btu per pound of dry air
Wet-bulb and dewpoint temperatures
Wet-bulb lines
Relative humidity
Cu ft per lb of dry air
Dry-bulb temperature, F

EXAMPLE: What are air properties at 80 db, 65 wb? Relative humidity = 43%. Moisture content = 68.3 gr/lb. Dewpoint = 56.8 F. Total heat (1 lb dry air + heat of 68.5 gr water vapor) = 30.0 Btu/lb. Specific volume = 13.81 cu ft/lb dry air (13.81 cu ft actually weighs 1.0098 lb: 1 lb dry air + 68.5 gr moisture at 7000 gr/lb). Vapor pressure = 0.228 psia

HOW TO MEASURE "AIR"

Atmospheric air is a mixture of dry air and water vapor. Atmospheric pressure is sum of *partial pressures* of air and water vapor, each acting as if it alone occupied any unit volume. Since weight of moisture per unit volume is small, partial pressure is extremely low. Thus we have "steam" at the low temperatures of the atmosphere.

WATER VAPOR always acts as if no air were present. At any given pressure, water vaporizes or condenses at a fixed temperature, known as *saturation* temperature. Put another way, *saturated vapor* at any given temperature has a fixed pressure and density, as listed in steam tables (pp 89-91, Part I).

To apply this, assume a cu ft of air at 70 F, with 0.00041 lb moisture. From steam tables, saturated-vapor density at 70 F is 0.00115 lb/cu ft.

RELATIVE HUMIDITY. Our cu ft obviously holds less moisture than it could. *Relative humidity* measures this. Ratio is 41/115 or 36% relative humidity. Note that basis is volume — *cu ft* of *moist* air. *Percentage humidity* is *weight* of moisture *actually* mixed with one lb *dry* air, compared to weight one lb *could* hold at same temperature.

DEWPOINT. Steam tables show a saturation temperature of 40 F corresponding to 0.00041 lb vapor per cu ft. If we cool to 40 F, we get a *saturated mixture*—100% relative humidity. Any attempt to cool further will cause some moisture to condense. Temperature at which this starts, 40 F in this case, is *dewpoint*. For any air-vapor mixture, dewpoint depends only on amount of moisture present.

LATENT, SENSIBLE HEAT. To vaporize water we add heat, to condense it we take heat away. It's same amount — about 1050 Btu/lb for air-conditioning temperatures. Exact amount of this *latent heat* for changing *state* varies with dewpoint. *Sensible heat* is what changes *temperature*. Amount depends on temperature and specific heat (about 0.24 Btu/lb for dry air).

TOTAL HEAT. For dry air, sensible heat is total. For water vapor, total is sensible plus latent heat. Neglecting small sensible heat of vapor, total heat of moist air is dry-air sensible heat plus vapor latent heat.

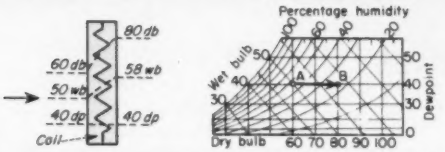
WET-BULB THERMOMETER is an ordinary one with wetted gauze over bulb. In moving air, some of water evaporates, takes heat from rest, lowers temperature. How much depends on air dryness and temperature. So wet-bulb temperature, with usual "dry-bulb" reading, gages moisture content.

PSYCHROMETRIC CHARTS plot properties of air-vapor mixture. Knowing any two properties — usually db and wb — we can find all others. GE chart, above, gives all answers directly (see example). Trane chart, used in cut-down form on facing page, uses an auxiliary ruler to get some values. Note that GE chart plots relative humidity, Trane percentage moisture. Horizontal lines on GE are moisture content, on Trane are dewpoint. Other forms of charts are used: all serve same purposes — finding air properties, tracing air-conditioning processes.

REMEMBER THESE AIR FACTS

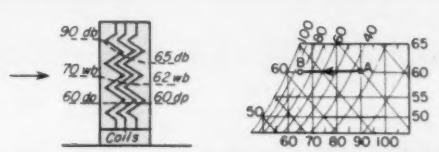
1. Total heat of moist air varies with wet-bulb temperature
2. Sensible heat depends on dry bulb, latent heat on dewpoint
3. Dry bulb, wet bulb and dewpoint are the same for a saturated mixture
4. Dewpoint is fixed by the amount of moisture present

BASIC AIR CONDITIONING PROCESSES



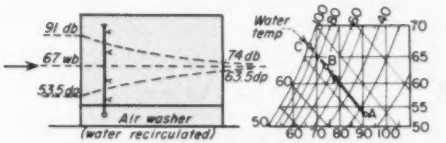
1. HEATING WITHOUT MOISTURE CHANGE

No moisture change in heating coil (diagram) means dewpoint, latent heat stay same. Adding sensible heat means higher total heat, dry bulb, wet bulb. Process shows on chart as A-B



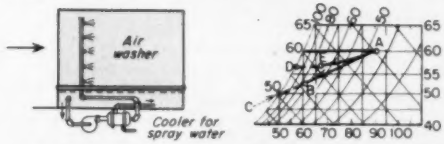
2. COOLING WITHOUT MOISTURE CHANGE

If we don't cool enough to cause condensation, removing sensible heat lowers dry bulb without dewpoint change. With no change in latent heat, total heat goes down, wet bulb falls



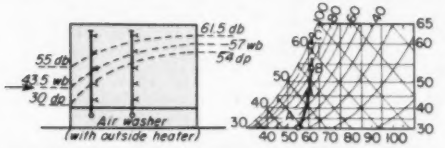
3. COOLING, HUMIDIFYING BY SPRAYS

With recirculated spray water at air's wet bulb temperature, there's no heat transfer, no change in air total heat. Some air sensible heat becomes latent, so water evaporates. Dry bulb drops (cooling), air picks up moisture (humidification) and dewpoint rises. Dry bulb and dewpoint approach wet bulb



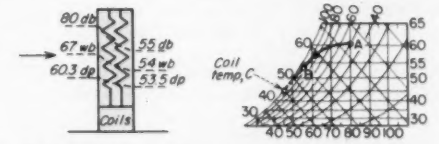
4. COOLING, DEHUMIDIFYING BY SPRAYS

With spray water held below air's dewpoint by outside cooler, air gives up heat to water. Dry bulb, wet bulb, dewpoint fall. Some moisture condenses out. If water temperature stayed same, line A-B would apply, C being water temperature. But water heats to temperature D, so line A-E shows the practical case



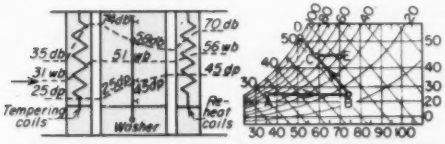
5. HEATING, HUMIDIFYING BY SPRAYS

Heater (connected like cooler of 4) keeps water temperature above air dry bulb. Water heats air so dry bulb, wet bulb, dewpoint rise. Water temperature falls. Line A-B shows air's changes, C is final water temperature, which air approaches



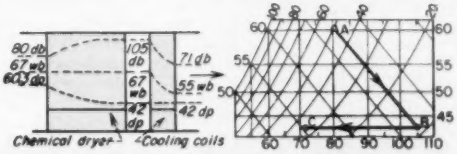
6. COOLING, DEHUMIDIFYING BY COILS

With coil temperature below air initial dewpoint, dry bulb, wet bulb and dewpoint fall, moisture condenses out. Air conditions change along line A-B. How close air approaches coil temperature, C, depends on design, number of sections, etc



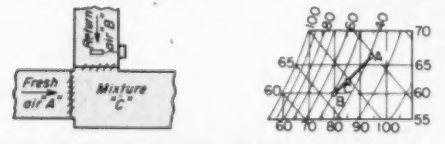
7. COIL HEATING, SPRAY HUMIDIFYING

Tempering coils ahead of washer raise dry bulb, wet bulb, as in 1. In washer with recirculated spray water (like 3), wet bulb stays same, dry bulb falls, dewpoint rises, air moisture goes up. Reheat coils boost dry bulb, lower percent humidity



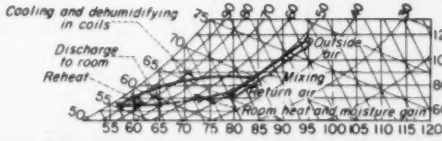
8. CHEMICAL DRYING, COIL COOLING

Water vapor is absorbed by chemical, so dewpoint falls. Latent heat released by condensation raises air dry bulb with no change in wet bulb. Cooling coils take out sensible heat so dry bulb and wet bulb fall while dewpoint remains unchanged



9. MIXING FRESH AND RETURN AIR

Fresh air A mixes with return air B to form mixture C. Where point C falls along line A-B depends on relative amounts of air at A and B. Distance A-C (as measured on chart) is to distance C-B as volume of air at B is to volume of air at A



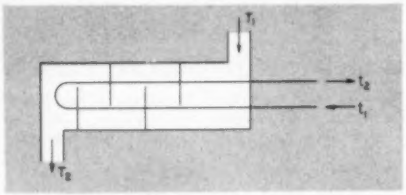
10. TYPICAL AIR-CONDITIONING SYSTEM

On GE chart (facing page) complete conditioning cycle looks like this. Outside and return air mix, then are cooled, dehumidified by coils. Reheat brings to final conditions. In room, air picks up heat and moisture before going to return

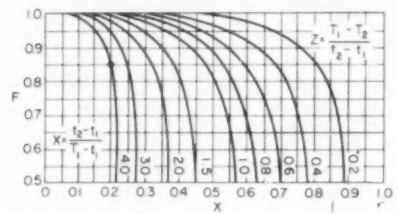
HEAT-TRANSFER EQUIPMENT

Compiled by
T G HICKS, Assistant Editor

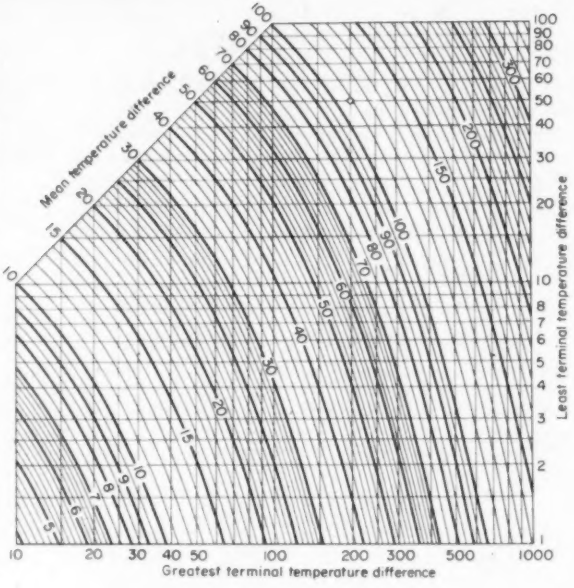
MEAN TEMPERATURE DIFFERENCE



CROSS-FLOW heat exchanger. T_1 and T_2 are hot-fluid entering, leaving temperatures; t_1, t_2 for cold fluid



CORRECTION CHART for single-pass-shell, multi-pass-tube exchangers (above). Multiply F times LMTD



LMTD CHART used directly for single-pass (parallel or counterflow) exchangers, multi-pass condensers

Part one, page 87, gave the fundamental equation for heat transfer as Btu per hr = over-all coefficient U × transfer area, sq ft × mean temperature difference. In complex problems, such as heat exchangers, where temperature of one or both mediums changes during heat transfer, use *logarithmic* mean temperature difference (LMTD).

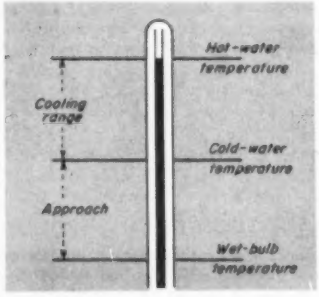
LMTD CHART. Chart, right above, gives LMTD for single-pass heat exchangers, with or without cross baffles in shell, and for condensers, regardless of number of passes made by cooling fluid. Greatest terminal difference for counterflow is usually entering hot fluid T_1 minus leaving cold fluid t_2. Least terminal difference: leaving hot fluid T_2 minus entering cold fluid t_1.

CROSS FLOW. LMTD chart is also good for single-pass shell, multi-pass-tube exchangers, sketch above, if correction factor, chart left, is used.

EXAMPLE. Heat exchanger with one shell pass, four tube passes. T_1 is 400 F, T_2 = 200 F, t_1 = 150 F, t_2 = 200 F.

Solution: $T_1 - t_2 = 200$ F. $T_2 - t_1 = 50$ F. Chart gives 109 LMTD. $Z = (400 - 200) \div (200 - 150) = 4$. $X = (200 - 150) \div (400 - 150) = 0.2$. F, from chart = 0.85. Effective mean temperature difference = 0.85 × 109 = 92.6 F.

COOLING PONDS, TOWERS



HEAT LOAD, Btu per hr, equals cooling range, deg F × lb water cooled per hr

In evaporating at normal atmospheric conditions, 1 lb water removes about 1050 Btu to cool the remaining water. Lowest theoretical temperature water can be cooled to this way is air's *wet-bulb* temperature. Difference between actual cold-water temperature and air's wet-bulb is the *approach*, in deg F. Difference between hot and cold water temp is the *cooling range*.

COOLING PONDS to cool condensing water must evaporate 1 lb water per lb of steam condensed. One sq ft cools 4 to 6 lb water per hr from 100 to 70 F.

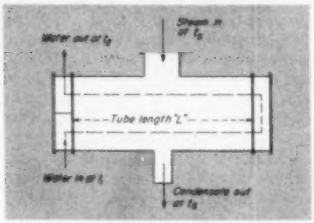
SPRAY PONDS are smaller for same job, use nozzles to break water into fine spray, speed evaporation. Pressures range from 3 to 15 psi. About 3% of water is evaporated. Power consumed ranges from 0.75% of output of prime mover served for low heads to 2% at high heads.

Pond areas are about 1 sq ft per 150 lb water per hr for 500-hp plants, 1 sq ft per 250 lb water for 5000-hp plants; depth needn't be over 3 ft. Lower final water temperature is obtainable with 10- to 20-deg-F cooling ranges than 30- to 40-deg-F ranges.

COOLING TOWERS mix air and water in a confined space, using either natural or mechanical draft.

In general a tower with a large cooling range and small gpm capacity is more economical than one with a small cooling range and large gpm ca-

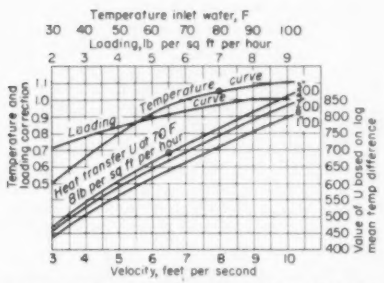
SURFACE CONDENSERS



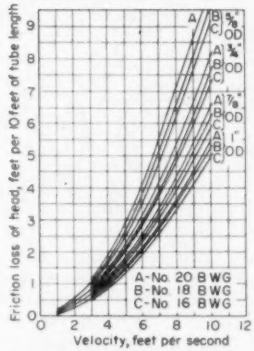
SURFACE CONDENSER section with temperatures used in performance calculations

STANDARD CONDENSER TUBE DATA

Tube OD, in.	Tube gage, Bwg	Tube ID, in.	Surface area, sq ft per ft length Outside	Inside	Velocity, fps for 1 gpm	Value of k for number of tube passes One	Two	Three
3/4	18	0.652	0.1963	0.1706	0.9611	0.188	0.377	0.565
	16	0.620	0.1963	0.1613	1.063	0.208	0.417	0.625
	14	0.584	0.1963	0.1528	1.198	0.235	0.470	0.705
7/8	18	0.777	0.2291	0.2034	0.6670	0.155	0.310	0.465
	16	0.745	0.2291	0.1951	0.7360	0.168	0.337	0.505
	14	0.709	0.2291	0.1856	0.8126	0.186	0.372	0.558
1	18	0.902	0.2618	0.2361	0.5022	0.131	0.263	0.394
	16	0.870	0.2618	0.2277	0.5398	0.141	0.283	0.424
	14	0.834	0.2618	0.2183	0.5874	0.154	0.308	0.461


Temperature inlet water, F
30 40 50 60 70 80 90 100
Loading, lb per sq ft per hour
2 3 4 5 6 7 8 9
Temperature and loading correction
Temperature curve
Loading
Heat transfer U at 70 F, Btu per sq ft per hour
Value of U based on log mean temp difference
Velocity, feet per second

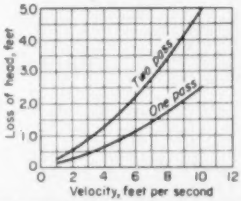
CONDENSER HEAT RATES for clean tubes, inlet water at 70 F, loading under 8 lb. steam/hr/sq ft



TUBE HEAT LOSS. Multiply by L/10 times number of passes

X AND e^x

x	e^x	x	e^x	x	e^x
0.0	1.0	1.2	3.32	2.4	11.0
0.2	1.22	1.4	4.05	2.6	13.5
0.4	1.49	1.6	4.95	2.8	16.4
0.6	1.82	1.8	6.04	3.0	20.1
0.8	2.23	2.0	7.39	3.2	24.5
1.0	2.72	2.2	9.02	3.4	29.9



WATER-BOX LOSSES. Add to total tube loss for total head loss through condenser

Curves* and tables this page show how to find (1) cooling water flow, (2) tube surface area, (3) outlet-water temperature, (4) cooling-water head loss.

HEAT RATE CHART, left above, shows expected heat-transfer rate for new, clean Muntz-metal, Admiralty, red-brass, aluminum-brass, copper and arsenical-copper tubes. With copper-nickel tubing, reduce heat rate 10%. Correct heat rate for cooling-water inlet temperature other than 70 F and loadings below 8 lb steam condensed per hr per sq ft of surface.

PERFORMANCE LIMITS. Heat-rate table also assumes (1) minimum water velocity 3 fps, (2) minimum absolute pressure in shell 0.7 in. Hg, (3) minimum terminal difference $(t_s\text{-}t_2)=5$ F.

COOLING-WATER FLOW.

$$G = \frac{950\ S}{500\ (t_2 - t_1)} = \frac{1.9S}{t_2 - t_1}$$ where

G = cooling-water flow, gpm
S = steam condensed, lb per hr
t_2 = outlet-water temperature, F
t_1 = inlet water temperature, F

(Note: 950 is Btu assumed to be removed from 1 lb of steam)

TUBE SURFACE AREA.

$A = (kL/V)\ G$ where
A = condenser surface area, sq ft
k = a constant (from above table)
L = tube length per pass, ft
V = water velocity, fps

OUTLET WATER TEMPERATURE.

$$t_2 = t_s - \frac{t_s - t_1}{e^x}$$ where

$x = (kL/V) \times U/500)$
$e^x = 2.7183^x$ (from above table)
t_s = saturated steam temperature corresponding to absolute pressure in condenser shell, F.
U = heat-transfer rate, Btu per sq ft per hr per deg F LMTD.

EXAMPLE. Find condenser area, cooling water flow, outlet temperature.

Steam condensed, S.....25,000 lb per hr
Condenser backpressure.....2 in. Hg abs
Steam temperature, t_s.....101.1 F
Inlet water temperature, t_1.....80 F
Tube length per pass, L.....14 ft
Water velocity, V.....6.5 fps
Number of passes.....2
Tube size and gage.....¾ in., No. 18 Bwg
Cleanliness factor.....0.80

Solution: From table, k = 0.377.

$kL/V = 14 \times 0.377/6.5 = 0.812$

Coefficient U (uncorrected for loading but corrected for temperature and cleanliness factor) is

$U = 690 \times 1.04 \times 0.80 = 574$

where 690 is U uncorrected and 1.04 is the temperature correction.

$x = (kL/V) \times (U/500)$
$= 0.812\ (574/500) = 0.933$
e^x (interpolated from table) = 2.54

Outlet water temperature is then

$$t_2 = 101.1 - \frac{101.1 - 80}{2.54} = 92.8\ \text{F}$$

(Check: $t_s - t_2 = 101.1 - 92.8 = 8.3$ F, which is greater than minimum terminal difference of 5 F.)

Cooling water flow then is

$$G = \frac{1.9 \times 25{,}000}{92.8 - 80} = 3700$$

Condenser tube surface area is

$A = 0.812 \times 3700 = 3000$ sq ft

(Check loading: 25,000 lb. per hr/3000 sq ft 8.33 lb per hr per sq ft so no correction is needed for loading.)

*Heat Exchange Institute

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pacity. Increasing cooling-water flow does *not* lower cold-water temperature.

HEIGHT. With 25- to 35-deg-F cooling range, following water travels (nozzle to basin) are typical for counterflow cooling:

Approach	Travel
15 to 20 deg F	15 to 20 ft
10 to 15 deg F	25 to 30 ft
4 to 8 deg F	35 to 40 ft

For cross-flow cooling, increase above heights 20 to 30%, for parallel-flow cooling — 40 to 50%.

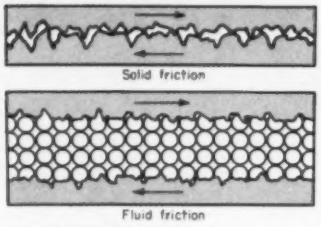
HEAT LOADS. For cooling diesel jackets, figure about 25% of heat in fuel will pass to water. On refrigeration jobs: 250 Btu per min per ton for compression plants, 550 Btu per min per ton for absorption units.

CORRECTIONS IN PART ONE: Page 99, under "Pressure head", sentence should read "Pressure head, in feet, equals 2.31 times the pressure in psi..." Page 85, under "Beam problems" answer to second example is 6470 ÷ 12 = 539 ft. (15-ft beam length was not converted to inches in solving this example.)

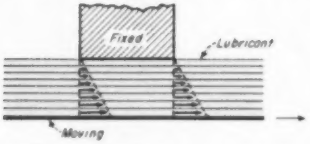
LUBRICATION

Compiled by J J O'CONNOR, Associate Editor

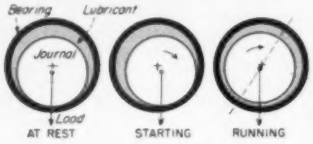
HOW LUBRICANTS WORK



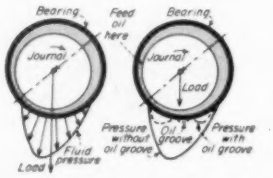
OIL MOLECULES separate coarse uneven surfaces so solid bodies can slide past each other with a minimum of friction



LUBRICANT divides into very thin layers. One layer sticks to moving surface, travels with it. Each successive layer lags: last layer sticks to fixed body



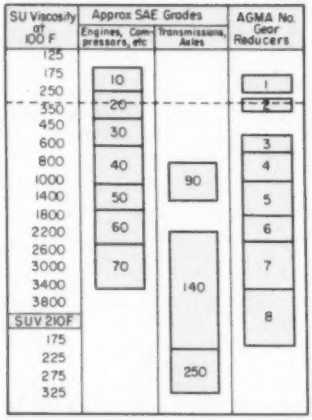
WHEN SHAFT SPINS fast enough, lubricant is squeezed into a wedge that has enough pressure to separate the surfaces, float shaft, support the load



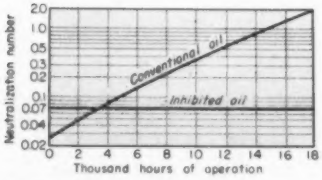
PRESSURE pattern, left, built up by spinning shaft is destroyed by grooving in the converging section. Pressure at oil groove is pressure at which lube is fed

Purpose of lubrication is to overcome friction (and also carry away heat). It converts *solid friction* of two dry bodies in contact to *fluid friction* of a separating layer of liquid or semi-liquid lubricant. This lubricant must (1) *form a slippery coating* on contacting surfaces so they slide freely past each other and (2) *exert sufficient pressure* to keep surfaces apart. For this, three things are necessary: (1) *thickness of lubricant layer* must be sufficient to keep high spots of rough metal surfaces from piercing through to make contact, (2) lubricant must have sufficient *lubricity* (slipperiness) for its molecules to slide freely past each other and (3) oil must have sufficient *viscosity* (resistance to flow) to build up the necessary pressure to keep the solid surfaces apart. If viscosity alone does not provide enough fluid pressure, pressure can be supplied *externally* by a pump or *developed* by the *wedging action* of *non-parallel* surfaces — such as the converging section of journal bearing at left, or the pivoted segments of Kingsbury thrust bearings.

PROPERTIES OF COMMERCIAL LUBRICANTS



VISCOSITY RANGES of commercially rated lubricating oils with 75 viscosity index



NEUTRALIZATION NUMBER (acidity) of oil increases with time unless inhibited

VISCOSITY in the U.S. is the number of seconds it takes 60 cc of an oil to flow through the standard orifice of a Saybolt Universal viscometer at 100, 130 or 210 F. A 400-SSU-at-100 oil means it took 400 sec for 60 cc to flow through a Saybolt Universal viscometer at 100 F. (England uses a Redwood viscometer, Europe an Engler.)

VISCOSITY INDEX. Viscosity decreases with temperature rise; oil becomes thinner. An oil's *viscosity index* is a relative measure of how oil's viscosity increases when cooled from 210 F to 100 F. When scale was first set up (1929) lube-oil fractions from Pennsylvania (parafinic) crude were assigned the VI of 100, as they changed least. Fractions from Coastal (napthenic) crude changed most, were given a VI of zero. All other VI are relative to these. Since 1929, oils have been developed with VI's higher than 100 for high-temperature work (such as internal combustion engines).

SPECIFIC GRAVITY. This is weight of oil compared to the weight of an equal volume of water, both at 60 F. Another method of measuring is *degrees API.*

$$\text{Specific gravity } 60/60 = \frac{141.5}{131.5 + \text{deg API}}$$

FLASH, FIRE, POUR POINTS. Flashpoint is temperature at which oil vaporizes enough to ignite momentarily when flame is brought near. Firepoint is temperature at which oil vaporizes enough to keep on burning. A low flashpoint means oil evaporates more readily in service. Pourpoint is temperature at which lube refuses to run — important in low-temperature work.

NEUTRALIZATION NUMBER. Oils in service tend to become acid, may cause corrosion, deposits, etc in time. Neutralization number is the weight in milligrams of potassium hydroxide required to neutralize one gram of oil.

LUBRICANTS IN GENERAL. Oils are usually those lubricants that are fluid at room temperature — mostly petroleum oils, but others are used.

Greases are mixtures of petroleum products with soaps (lime, soda, aluminum, metallic). Metallic soaps (forms of calcium, sodium, potassium, lithium) have good retention in bearings, take high temperatures, pressures.

Solid materials such as graphite, finely ground mica, asbestos and yarn are sometimes used as lubricants.

Silicon compounds (silicones) recently developed stand up well under heavy loads and widely varying temperatures.

ADDITIVES. These are specific chemical compounds added to an oil to improve certain chemical or physical properties such as stability, lubricity, avoiding rust or deposits, etc. In the future additives may become more important than the oil, the oil merely serving as a solvent for the additive.

FIGURING HEAT LOSS, ECONOMIC THICKNESS

Table*, lower right, shows loss for various thicknesses of 85% magnesia insulation applied to pipelines or flat surfaces 300 deg F hotter than surrounding air. Data can be used approximately for such insulations as mineral wool and sponge-felted asbestos. If temperature difference is greater or less than 300 F, apply factor from chart.

EXAMPLE: A 220-ft run of 4-in. pipe insulated with double-standard insulation carries process steam (saturated) at 600 psig through a room at 80 F. What is hourly heat loss?

Solution. Pipe temperature is 490 F, from scale, so temperature difference is 410 F. Factor from chart is 1.45. Loss per ft of pipe run at 300 F, from table, is 89.4 Btu. Total loss is 89.4 × 1.45 × 220 = 28,500 Btu per hr.

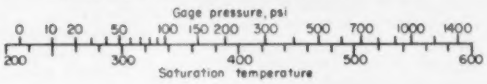
ECONOMIC THICKNESS. To figure economic thickness for insulation, draw up a table for the specific job similar to one shown below for a heater.

Thickness, inches	Total insulation cost installed	Total yearly dollar loss	Cost of added insulation thickness	Added saving	Years for added saving to pay added cost
0	—	$720	—	—	—
1	$200	180	$200	$540	0.37
1½	260	126	60	54	1.11
2	318	96	58	30	1.93
2½	374	76	56	20	2.80
3	429	62	55	14	3.92

Then pick the thickness that pays off in the time required by your plant's financial policy. If insulation above has to pay off within three years, use 2½-in.

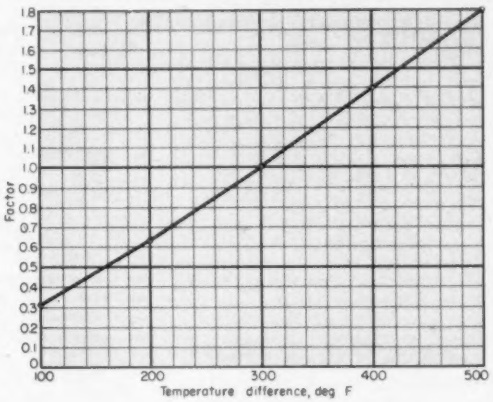
*From Magnesia Insulation Manufacturers Association.

PRESSURE-TEMPERATURE SCALE



TEMPERATURE CORRECTION FACTOR

(Based on 300-deg F temperature difference as normal)



COMMERCIAL INSULATION

KINDS AND SHAPES OF HEAT INSULATION FOR WARM SURFACES	Hair	Air-cell asbestos	Asbestos, fibrous	85% Magnesia	Sponge-felted asbestos paper	Mineral wool	Diatomaceous silica (calcined)	Diatomaceous silica (calcined brick)	Crumpled aluminum foil
Usual max temperature	200 F	300 F	750 F	600 F	700 F	1000 F	1900 F	2500 F	
Loose or granulated				✓		✓	✓		
Cement			✓	✓		✓			
Blankets or batts	✓	✓				✓			
Sheets (flexible)		✓	✓		✓	✓			✓
Boards or blocks (stiff)		✓	✓	✓	✓	✓	✓		
Molded segments				✓					
Shaped sections	✓	✓	✓	✓	✓	✓	✓		
Bricks								✓	

HEAT LOSS THROUGH 85% MAGNESIA

(Multiply by correction factor from above chart)

Pipe size, inches	Insulation thickness, inches	Heat loss, Btu*
1/2	7/8 (s)	51.9
	1 1/2	40.8
	1 29/32 (ds)	36.9
	2	36.2
	2 1/2	33.0
	3	30.9
3/4	7/8 (s)	59.1
	1 1/2	45.7
	1 29/32 (ds)	41.1
	2	40.2
	2 1/2	36.5
	3	33.9
1	7/8 (s)	67.8
	1 1/2	51.7
	1 29/32 (ds)	46.0
	2	45.0
	2 1/2	40.7
	3	37.5
1 1/4	7/8 (s)	79.5
	1 1/2	59.2
	1 29/32 (ds)	52.4
	2	51.1
	2 1/2	45.7
	3	42.0
1 1/2	7/8 (s)	86.7
	1 1/2	64.2
	1 29/32 (ds)	56.6
	2	55.1
	2 1/2	49.2
	3	45.0
2	1 1/32 (s)	92.4
	1 1/2	74.0
	2	63.0
	2 5/32 (ds)	60.5
	2 1/2	55.8
	3	50.6
2 1/2	1 1/32 (s)	106
	1 1/2	84.3
	2	71.1
	2 5/32 (ds)	67.8
	2 1/2	62.4
	3	56.6
3	1 1/32 (s)	123
	1 1/2	96.9
	2	81.0
	2 5/32 (ds)	77.4
	2 1/2	70.8
	3	63.6
3 1/2	1 1/32 (s)	137
	1 1/2	107
	2	88.5
	2 5/32 (ds)	84.7
	2 1/2	77.3
	3	69.4
4	1 1/8 (s)	141
	1 1/2	116
	2	96.5
	2 1/4 (ds)	89.4
	2 1/2	83.6
	3	74.7
5	1 1/8 (s)	170
	1 1/2	138
	2	113
	2 5/16 (ds)	103
	2 1/2	97.5
	3	86.4
6	1 1/8 (s)	195
	1 1/2	158
	2	129
	2 5/16 (ds)	117
	2 1/2	111
	3	97.8
8	1 1/4 (s)	225
	1 1/2	197
	2	160
	2 1/2 (ds)	136
	3	119
10	1 1/4 (s)	272
	1 1/2	238
	2	192
	2 1/2 (ds)	162
	3	141

Flat insulation blocks with 1/2-in. asbestos cement finish.	1	96.2**
	1 1/2	69.9
	2	54.9
	2 1/2	45.2
	3	38.4
	3 1/2	33.4
	4	29.5

(s) Standard thickness (ds) double-standard thickness.

* Btu per hour per foot of pipe length at 300-deg-F temperature difference.

** Btu per hour per square foot of insulation surface at 300-deg-F temperature difference.

ELECTRICAL MACHINERY

Compiled by J J O'CONNOR, Associate Editor

TIPS ON SELECTING MOTORS

First step in selecting a motor for a particular drive is to obtain data listed at right. Motors generally operate at best power factor and efficiency when fully loaded.

TORQUE. Starting torque needed by load must be less than required starting torque of proposed motor. Motor torque must never fall below driven machine's torque needs in going from standstill to full speed.

Torque requirements of some loads may fluctuate between wide limits. Although average torque may be low, many torque peaks may be well above full-load torque. If load-torque impulses are repeated frequently (air compressor), it's best to use a high-slip motor with a flywheel. But if load is generally steady at full load, you can use a more efficient low-slip motor. Only in this case, any intermittent load peaks are taken directly by the motor and reflect back into power system. Also breakdown (maximum motor torque) must be higher than load-peak torque.

ENCLOSURES. Atmospheric conditions surrounding motor determine enclosure used. The more enclosed a motor, the more it costs and the hotter it tends to run. Totally-enclosed motors may require a larger frame size for a given hp than open or protected motors.

INSULATION. This, likewise, is determined by surrounding atmosphere and operating temperature. Ambient (room) temperature is generally assumed to be 40 C. Total temperature motor reaches directly influences insulation life. Each 10-C rise in max temp halves effective life of *Class A* and *B* insulations.

Motor temperature rise is maximum temperature (over ambient) measured with an external thermometer. "Hot-spot" allowance takes care of temperature difference between external reading and hottest spot within windings. Service-factor allows for continuous overload — 15% for general-purpose open, protected or drip-proof motors.

VARIABLE CYCLE. Where load varies according to some regular cycle, it would not be economical to select a motor that matches the peak load.

Instead (for ac induction motors where speed is not varied) calculate hp needed on the *root-mean-square* (rms) basis, example right. *Rms* hp is equivalent continuous hp that would produce same heat in motor as cycle operation. Torque-speed relation of motor should still match that of load.

FACTS TO CONSIDER

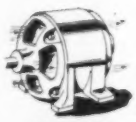
REQUIREMENTS OF DRIVEN MACHINE:

1. Hp needed
2. Torque range
3. Operating cycle—frequency of starts and stops
4. Speed
5. Operating position—horizontal, vertical or tilted
6. Direction of rotation
7. Endplay and thrust
8. Ambient (room) temperature
9. Surrounding conditions—water, gas, corrosion, dust, outdoor, etc

ELECTRICAL SUPPLY:

1. Voltage of power system
2. Number of phases
3. Frequency
4. Limitations on starting current
5. Effect of demand, energy on power rates

TYPES OF ENCLOSURES



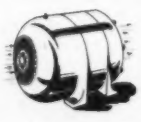
OPEN-TYPE has full openings in frame and endbells for maximum ventilation, is lowest cost enclosure

SEMI-PROTECTED has screens in top openings to keep out falling objects. **PROTECTED** has screens in bottom too

DRIP-PROOF has upper parts covered to keep out drippings falling at angle not over 15 deg from vertical

SPLASH-PROOF is baffled at bottom to keep out particles coming at angle not over 100 deg from vertical

TOTALLY-ENCLOSED can be non-ventilated, separately ventilated, or explosion proof for hazardous atmospheres



FAN-COOLED totally-enclosed motor has double covers. Fan, behind vented outer shroud, is run by motor

INSULATION, TEMPERATURE

CLASS A (cotton, silk, paper or other organics impregnated with insulating varnish) is considered standard for most applications, allows 105 C total temperature.

40 C ambient
40 C rise by thermometer
15 C "hot-spot" allowance
10 C service factor
105 C total temperature

CLASS B (mica, asbestos, fiber-glass, other inorganics) allows 130 C total temperature

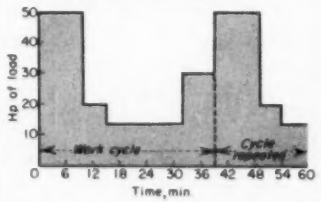
40 C ambient
70 C rise by thermometer
20 C "hot-spot" allowance
130 C total temperature

CLASS H (including silicone family) is for special high-temperature applications

SPECIAL CLASS A is highly resistant, but not "proof," against severe moisture, dampness; conductive, corrosive or abrasive dusts and vapors

TROPICAL is for excessive moisture, high ambients, corrosion, fungus, vermin, insects

VARIABLE LOAD CYCLES



RMS HP: (1) square hp for each phase, multiply by time, (2) add, (3) divide by total time—include ⅓ "off" time, if any, for open motors, ½ for enclosed, (4) extract square root.

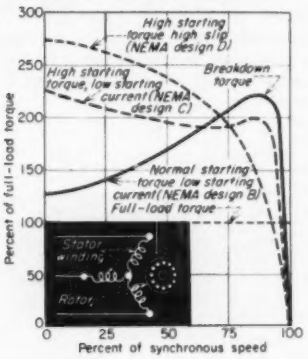
EXAMPLE: Find hp_{rms} for cycle plotted above

a. 50 hp, 10 min:	50×50×10 =	25,000 — 10
b. 20 hp, 5 min:	20×20× 5 =	2,000 — 5
c. 14 hp, 17 min:	14×14×17 =	3,332 — 17
d. 30 hp, 7 min:	30×30× 7 =	6,300 — 7
		36,632 ÷ 39 = 939

$Hp_{rms} = \sqrt{939} = 30.6$; use 30-hp motor

SQUIRREL-CAGE MOTORS

Squirrel-cage induction motors are classed by National Electric Manufacturers Assn. (NEMA) according to locked-rotor torque, breakdown torque, slip, starting current, etc. Common types are *Class B, C* and *D*.

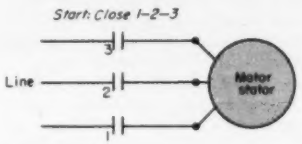

High starting torque high slip (NEMA design D)
High starting torque, low starting current (NEMA design C)
Breakdown torque
Normal starting torque low starting current (NEMA design B)
Full-load torque
Stator winding
Rotor
Percent of full-load torque
Percent of synchronous speed

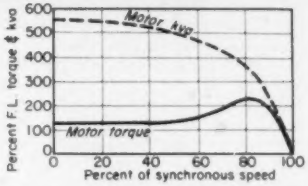
CLASS B, most common type, has *normal starting torque, low starting current.* Locked-rotor torque (minimum torque at standstill and full voltage) is not less than 100% full-load for 2- and 4-pole motors, 200 hp and less; 40 to 75% for larger 2-pole motors; 50 to 125% for larger 4-pole motors.

CLASS C features high starting torque (locked-rotor over 200%), low starting current. Breakdown torque not less than 190% full-load torque. Slip at full load is between 1½ and 3%.

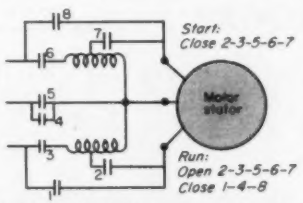
CLASS D have high slip, high starting torque, low starting current; are used on loads with high intermittent peaks. Driven machine usually has high-inertia flywheel. At no load motor has little slip; when peak load is applied, motor slip increases. Speed reduction lets driven machine absorb energy from flywheel rather than power line.

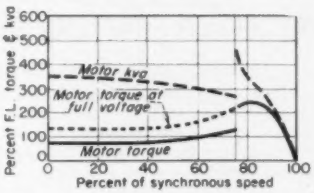
STARTING SQUIRREL-CAGE MOTORS



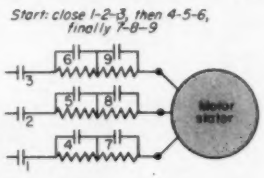


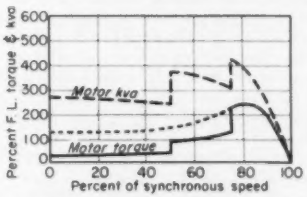
FULL-VOLTAGE is preferred where power sources allows kva inrush. Utility may want reduced voltage below certain hp, limit starting current to fixed % of full load





AUTO-TRANSFORMER reduces voltage on starting. Transferring to full voltage at 75% synchronous interrupts current, surges kva. Used on hand-operated compensators



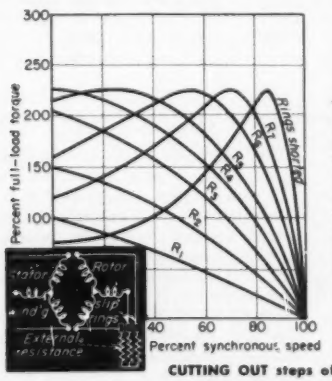


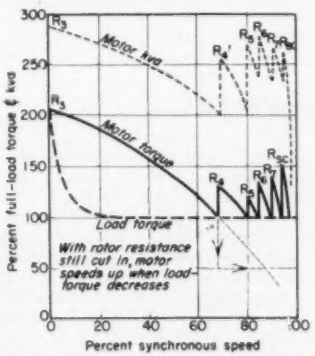
SERIES-RESISTANCE (or reactor) provides closed transition from start to run, raising motor kva and torque by steps when uninterrupted starting current is wanted

STARTING. Full-voltage, across-the-line starting is used where power supply permits and full-voltage torque and acceleration are not objectionable. Reduction in starting kva cuts locked-rotor and accelerating torques.

APPLICATIONS of squirrel-cage and other motors are listed in table, p. 111.

WOUND-ROTOR MOTORS




Motor kva
Motor torque
Load torque
With rotor resistance still cut in, motor speeds up when load torque decreases
Percent full-load torque & kva
Percent synchronous speed

CUTTING OUT steps of resistance as motor comes up to speed matches motor torque to load with a minimum starting kva

The wound-rotor (slip-ring) induction motor's rotor winding connects through sliprings to an external resistance that is cut in and out by a controller.

RESISTANCE vs TORQUE. Resistance of rotor winding affects torque developed at any speed. A high-resistance rotor gives high starting torque with low starting current. But low slip at full load, good efficiency and moderate rotor heating takes a low-resistance rotor. Left-hand curves (this page) show rotor-resistance effect on torque. With all resistance in, R_1, full-load starting torque is developed at less than 150% full-load current. Successively shorting out steps, at standstill, develops about 225% full-load torque at R_4. Cutting out more reduces stand-

(Continued on next page)

still torque. Motor operates like a squirrel-cage motor when all resistance is shorted out.

SPEED CONTROL. Having resistance left in, decreases speed regulation. Right-hand curves (preceding page) for a typical motor show that with only two steps shorted out, motor operates at 65% synchronous speed because motor torque equals load torque at that speed. But if load torque drops to 50% (arrow), motor shoots forward to about 85% synchronous speed.

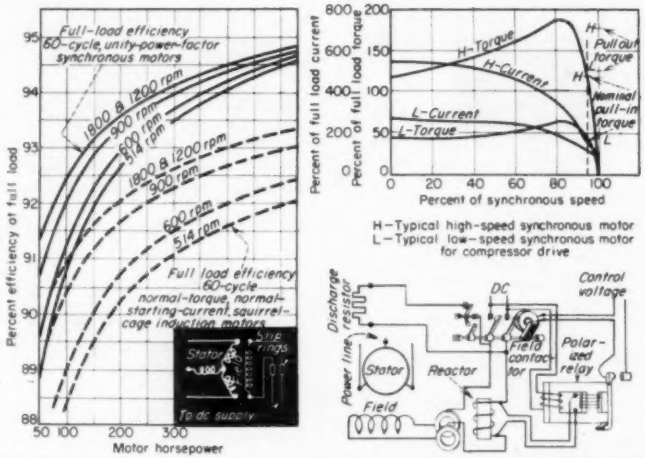
However slip rings are normally shorted after motor comes up to speed. Or, for short-time peak loads, motor is operated with a step or two of resistance cut in. At light loads, motor runs near synchronous speed. When peak loads come on, speed drops; flywheel effect of motor and load cushions power supply from load peak.

OTHER FEATURES. In addition to high-starting-torque, low-starting-current applications, wound-rotor motors are used (1) for high-inertia loads where high slip losses that would have to be dissipated in the rotor of a squirrel-cage motor, in coming up to speed, can be given off as heat in wound-rotor's external resistance (2) where frequent starting, stopping and speed control are needed (3) for continuous operation at reduced speed. (Example: boiler draft fan — combustion control varies external resistance to adjust speed, damper regulates air flow between step speeds and below 50% speed.)

CONTROLS used are across-the-line starters with proper protection (fuses, breakers, etc.) and secondary control with 5 to 7 resistance steps.

SYNCHRONOUS MOTORS

Synchronous motors run at a fixed or synchronous speed determined by line frequency and number of poles in machine. (Rpm = 120 × frequency ÷ number of poles.) Speed is kept constant by locking action of an externally excited dc field. Efficiency is 1 to 3% higher than that of same-size-and-speed induction or dc motors. Also synchronous motors can be operated at power factors from 1.0 down to 0.2 leading for plant power-factor correction. Standard ratings are 1.0 and 0.9 leading pf; machines rated down near 0.2 leading are called synchronous condensers.



CURVES, left, compare synchronous and squirrel-cage efficiencies. Top, right, shows typical torque-speed curves. Bottom, right, is typical starting control for energizing dc field to pull motor into synchronism as it comes up to synchronous speed

STARTING. Pure synchronous motors are not self-starting; so in practice they are built with damper or amortisseur windings. With the field coil shorted through discharge resistor, damper winding acts like a squirrel-cage rotor to bring motor practically to synchronous speed; then field is applied and motor pulls into synchronism, providing motor has developed sufficient "pull-in" torque. Once in synchronism, motor keeps constant speed as long as load torque does not exceed maximum or "pull-out" torque; then machine drops out of synchronism. Driven machine is usually started without load. Low-speed motors may be direct connected.

FIELD AND PF. While motors are rated for specific power factors . . . at constant power, increasing dc field current causes power factor to lead, decreasing field tends to make pf lag. But either case increases copper losses.

TYPES. Polyphase synchronous motors in general use are: (1) high-speed motors, 500 rpm up—(a) general-purpose, 500 to 1800 rpm, 200 hp and below, (b) high-speed units over 200 hp, including most 2-pole motors — (2) low-speed motors below 500 rpm, (3) special high-torque motors.

COSTS. Small high-speed synchronous motors cost more than comparable induction motors, but with low-speed and large high-speed motors, costs favor the synchronous motor. Cost of leading-pf motors increases approximately inversely proportional to the decrease from unity power factor.

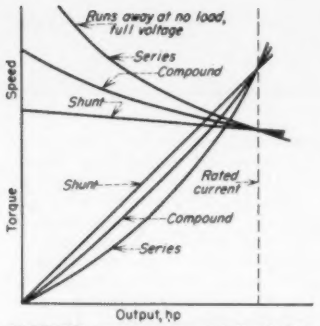
DC MOTORS, GENERATORS

Chief reason for using dc motors, assuming normal power source is ac, lies in the wide and economical ranges possible of speed control and starting torques. But for constant-speed service, ac motors are generally preferred because they are more rugged and have lower first cost.

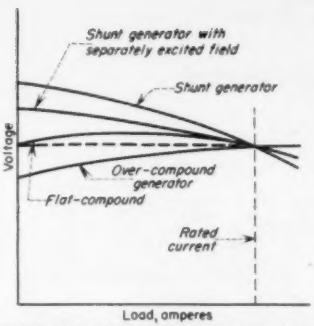
STARTING TORQUE. With a shunt motor, torque is proportional to armature current, because field flux remains practically constant for a given setting of the field rheostat. However, the flux of a series field is affected by the current through it. At light loads, flux varies directly with the current, so torque varies as the square of the current. The compound motor (usually cumulative) lies in between the shunt and series motors as to torque.

Upper limit of current input on starting is usually 1.5 to 2 times full-load current to avoid overheating the commutator, excessive feeder drops or peaking generator. Shunt-motor starting boxes usually allow 125% current at first notch. So motor can develop 125% starting torque. Series motors can develop higher starting torques at same current, since torque increases as current squared. Compound motors develop starting torques higher than shunt motors according to amount of compounding.

SPEED CONTROL. Shunt motor speeds drop only slightly (5% or less) from no load to full load. Decreasing field current raises speed; increasing field reduces speed. But speed is still prac-

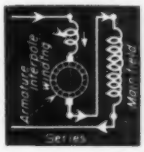


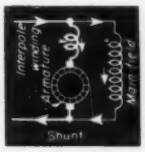
DC MOTOR torque varies with load; flat speed curves allow wide speed control

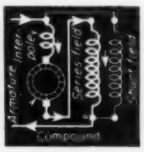


GENERATOR COMPOUNDING can be varied by resistors parallel with series field

COMPOUND MOTOR at right is cumulative, series field aids shunt. Differential compounding has series field opposed to the shunt field







tically constant for any one field setting. Speed can be controlled by resistance in the armature circuit but regulation is poor.

Series motor speeds decrease much more with increased load, and, conversely, begin to race at low loads, dangerously so if load is completely removed. Speed can be reduced by adding resistance into the armature circuit, increased by shunting the series field with resistance or short-circuiting series turns.

Compound motors have less constant speed than shunt motors and can be controlled by shunt-field rheostat.

GENERATORS. Output voltage of shunt generators tends to fall off with load. However, constant terminal voltage can be maintained by decreasing shunt field resistance as load increases. Compound generators can be designed to keep fairly constant output voltage (called flat compound) without external control, or even to increase output voltage as load increases (overcompounding).

SUMMARY OF MOTOR CHARACTERISTICS, APPLICATIONS

DC and Single-phase motors

Speed Regulation	Speed Control	Starting Torque	Pull-Out Torque	Applications
SERIES				
Varies inversely as the load. Races on light loads and full voltage	Zero to maximum depending on control and load	High. Varies as square of the voltage. Limited by commutation, heating and line capacity	High. Limited by commutation, heating and line capacity	Where high starting torque is required and speed can be regulated. Traction, bridges, hoists, gates, car dumpers, car retarders, etc
SHUNT				
Drops 3 to 5% from no load to full load	Any desired range depending on motor design and type of system	Good. With constant field, varies directly as voltage applied to armature	High. Limited by commutation, heating and line capacity	Where constant or adjustable speed is required and starting conditions are not severe. Fans, blowers, centrifugal pumps, conveyors, wood-working machines, metal-working machines, elevators
COMPOUND				
Drops 7 to 20% from no load to full load depending upon amount of compounding	Any desired range, depending upon motor design and type of control	Higher than for shunt, depending upon amount of compounding	High. Limited by commutation, heating and line capacity	Where high starting torque combined with fairly constant speed is required. Plunger pumps, punch presses, shears, bending rolls, geared elevators, conveyors, hoists
SPLIT-PHASE				
Drops about 10% from no load to full load	None	75% for large to 175% for small sizes	150% for large to 200% for small sizes	Constant-speed service where starting is easy. Small fans, centrifugal pumps and light-running machines, where polyphase current is not available
CAPACITOR				
Drops about 5% for large to 10% for small sizes	None	150 to 350% of full load, depending upon design and size	150% for large to 200% for small sizes	Constant-speed service for any starting duty and quiet operation, where polyphase current cannot be used
COMMUTATOR-TYPE				
Drops about 5% for large to 10% for small sizes	Repulsion-reduction, none. Brush-shifting types, 4 to 1 at full load	250% for large to 350% for small sizes	150% for large to 250% for small sizes	Constant-speed service for any starting duty where speed control is required and polyphase current cannot be used

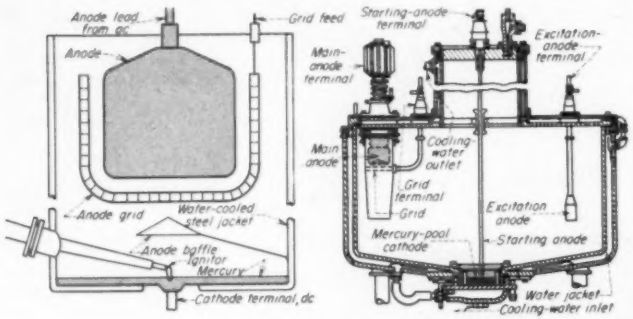
2- and 3-phase motors

Speed Regulation	Speed Control	Starting Torque	Pull-Out Torque	Applications
GENERAL-PURPOSE SQUIRREL-CAGE (Class B)				
Drops about 3% for large to 5% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	200% of full load for 2-pole to 105% for 16-pole designs	200% of full load	Constant-speed service where starting torque is not excessive. Fans, blowers, rotary compressors, centrifugal pumps
HIGH-TORQUE SQUIRREL-CAGE (Class C)				
Drops about 3% for large to 6% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	250% of full load for high-speed to 200% for low-speed designs	200% of full load	Constant-speed service where fairly high starting torque is required at infrequent intervals with starting current of about 400% of full load. Reciprocating pumps and compressors, crushers, etc.
HIGH-SLIP SQUIRREL-CAGE (Class D)				
Drops about 10 to 15% from no load to full load	None, except multi-speed types, designed for 2 to 4 fixed speeds	225 to 300% of full load, depending on speed with rotor resistance	200%. Will usually not stall until loaded to max. torque, which occurs at standstill	Constant-speed service and high-starting torque, if starting is not too frequent, and for taking high-peak loads with or without flywheels. Punch presses, shears, elevators, etc.
LOW-TORQUE SQUIRREL-CAGE (Class F)				
Drops about 3% for large to 5% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	50% of full load for high-speed to 90% for low-speed designs	150 to 170% of full load	Constant-speed service where starting duty is light. Fans, blowers, centrifugal pumps and similar loads
WOUND-ROTOR				
With rotor rings short-circuited, drops about 3% for large to 5% for small sizes	Speed can be reduced to 50% by rotor resistance to obtain stable operation. Speed varies inversely as load	Up to 300% depending upon external resistance in rotor circuit and how distributed	200% when rotor slip rings are short circuited	Where high starting torque with low starting current or where limited speed control is required. Fans, centrifugal and plunger pumps, compressors, conveyors, hoists, cranes
SYNCHRONOUS				
Constant	None, except special motors designed for 2 fixed speeds	40% for slow-speed to 160% for medium speed 80% pf designs. Special designs develop higher torques	Unity-pf motors 170%. 80%-pf motors 225%. Special designs up to 300%	For constant-speed service, direct connection to slow-speed machines and where power-factor correction is required

AC CONVERTERS

Compiled by J J O'CONNOR, Associate Editor

MERCURY-ARC RECTIFIERS



SINGLE-ANODE, MULTI-TANK rectifiers, or *ignitrons*, have an ignitor that starts cathode spot every cycle. Single tanks are grouped together in installations

MULTI-ANODE, SINGLE-TANK rectifiers have anode head consisting of several anodes, one or more for each phase. Once started, arc is kept by excitation anode

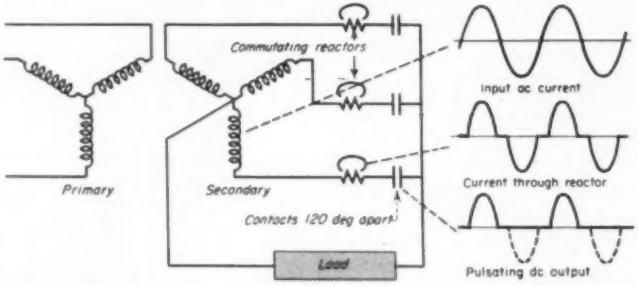
These rectifiers consist of carbon or iron *anode* and mercury-pool *cathode* sealed in a vacuum *tank*. When ac voltage is applied, current flows only on every other half cycle when anode is positive with respect to cathode. On just how much of the positive half-cycle current flows is determined by bias voltage applied to grid.

IGNITION. Before electrons can flow from cathode to anode, some mercury must be vaporized. This is done by (1) starting a cathode spot on top mercury pool every cycle from which electrons travel or (2) keeping a small pilot arc going continually.

EXCITRONS are a special type of single-anode tube with an excitation anode similar to multi-anode tube.

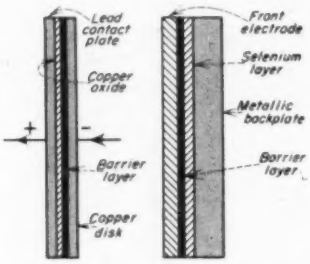
ARC BACK. Failure of vacuum is one cause of arc back and electrons will flow from anode to cathode.

MECHANICAL RECTIFIERS



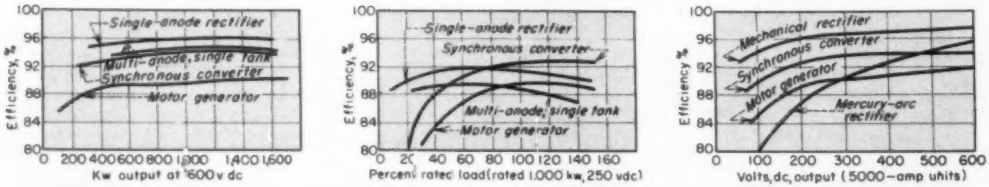
CONTACT CONVERTERS (mechanical rectifiers) produce dc from ac by making metallic contact between ac and dc system for each phase when each phase's voltage is on the positive half-cycle. Then contact is broken when ac phase reverses on the negative half-cycle. As current approaches zero at the end of each half-cycle, reactors assume almost infinite reactance, choking off current flow. At the end of positive half-cycles, contacts open; then close at end of negative half-cycle to conduct again

DISK-TYPE



METALLIC or disk rectifiers have small resistance to current flow in one direction, high resistance in opposite, so ac is passed on one half-cycle, blocked on the other. Three types are copper-oxide, selenium and magnesium-copper-sulfide

COMPARING RECTIFIER EFFICIENCIES



EFFICIENCY CURVES compare rectifier types under different conditions. Left: general curves of different ratings at constant voltage output. Center: common ratings at different loads. Right: Curves for constant current at different output voltages

We Mobilize for Freedom

CONTROLS . . . A Two-Edged Sword

It may seem dangerously premature to talk about getting rid of emergency government controls while all-out war is still an imminent possibility.

But success in this strange struggle for our freedom into which the Russian Communists have plunged us requires that we:

1. Maintain a whole battery of controls designed to speed defense production and curb inflation, and at the same time

2. Work to end the controls at the earliest possible moment.

Here is the reason why this editorial—fourth in a special series on mobilization for defense—is devoted to the need for a speedy release from controls.

If the Russian Communists can force us to maintain indefinitely the present system of government controls, they will have won a tremendous victory. They will have saddled us with a system of collectivism which, over a period of years, would be fairly certain death to freedom of business enterprise.

Make no mistake about it. This is not an argument against emergency controls. We need controls now to break a right of way for our mobilization program through the business boom. Indeed, the third editorial in this special series was titled "Why Controls Are Necessary." It stressed both the need for controls and the need for positive cooperation to make them work.

Controls Can Undermine Our Economy

But these controls surely chisel at the foundation of our normal economic system. So long as we have them, many if not most key business decisions will be made in Washington bureaus rather than in the free market place. For example, the *National Production Authority* administers a *Controlled* Materials Plan (italics ours) which directs the flow of basic metals, and decides who can use them for what purposes.

Happily, the people who operate these controls are not using the methods of a secret police state.

Even more happily, most of the leaders who have been drafted to manage the controls are not in love with their jobs. They are doing their best in the thankless task of making controls work. They recognize the danger of chronic controls.

But the fact remains that our economy is

operating under arrangements which carry it a long way toward the pattern of centralized control the Russians would inflict on the world.

The Wilson Plan

A plan for getting rid of these controls has already been developed. It was put together by our Director of Mobilization, Charles E. Wilson—while he was working day and night to set up the necessary emergency controls.

The Wilson Plan—if we escape all-out war—will strengthen our defenses and our economy. By 1953, it calls for:

1. Providing the weapons to equip an armed force of 3½ to 4 million, together with a supply of weapons for our allies.

2. Building a stockpile of weapons which, with current production, would be sufficient to carry on an all-out war for a year.

3. Building the manufacturing capacity by which we could rapidly expand our production of weapons if all-out war should come.

4. Increasing the productive capacity of industry enough to resume the expansion of our civilian economy.

With these jobs done our economy would be big enough and strong enough to meet both civilian and military requirements. And the government controls needed for mobilization could be speedily dropped.

Call for Sacrifice

The Wilson Plan requires a major effort—it means spending more than $50 billion a year for mobilization. That is almost 20 percent of our total production. And this cannot be done without sacrifice. For a time, particularly in the next year, living standards will drop.

But the sacrifice required is amazingly small. At the peak of the defense effort, civilians will still have available to meet their needs about as much as they did in any year before 1948.

To make the Wilson Plan succeed we must curb inflation. A second year of inflation such as that which we have had since the Korean war started would multiply disastrously the costs of our defense program. One key part of a successful program to curb inflationary pressure, which soon will be building up again, is a pay-as-we-go tax program. The second editorial in this series urged that we do our utmost to pay as we go.

We Cannot Out-Control the Communists

But, above all, to make the Wilson Plan work we must keep our sights set on the crucial importance of increased production. Our problem is to increase our capacity to produce so that we can carry both a major military program and an expanding civilian economy for as many years—General Bradley thinks it might be fifteen or twenty—as the menace of Russian Communist aggression persists.

If we do not produce enough to do this double job, we shall be confronted with the prospect of having to live indefinitely under government controls of the sort that have been set up since the start of the Korean war. That would be delightful to the Russian Communists. It would go far toward making over our economy on the Moscow model.

Even if we wanted to, we never could hope to out-control the Russians. They are miles ahead of us in that line. But we can out-produce them, by a tremendous margin. By doing that we shall travel the surest road to victory.

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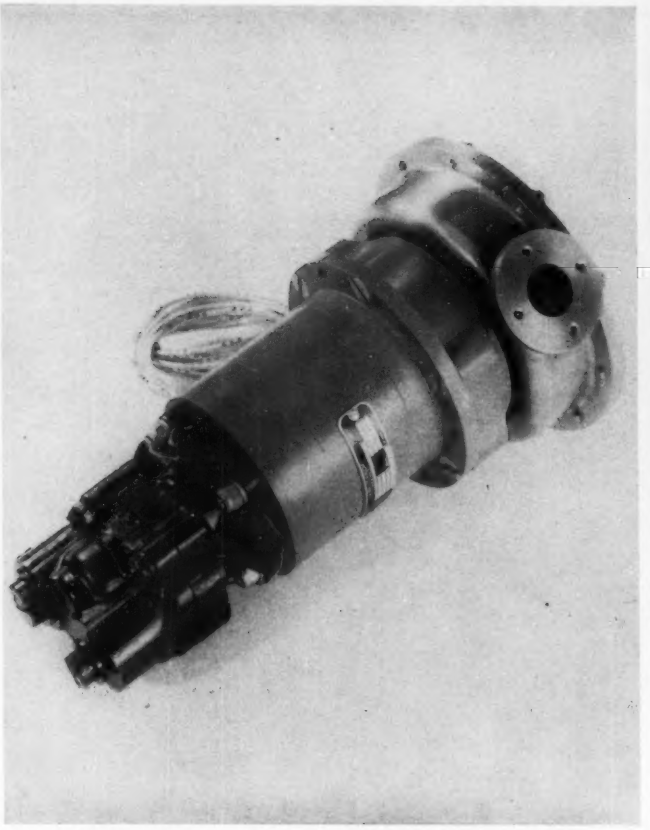


POWER PACKAGE for guided missiles supplies energy to run steering controls. Gas turbine drives pump and electric generator. Power gas comes from separate gas generator about same size as power unit. Gas generator is sized according to the length of operating time

LIGHT WEIGHT (16 lb) of tiny power unit makes it easily handled. It rides in guided missile as secondary source of power, a working passenger. Compact power plant has about same dimensions as milk bottle. Rugged construction gives it reliability needed for severe service

Mighty Midget Produces Pilot Power

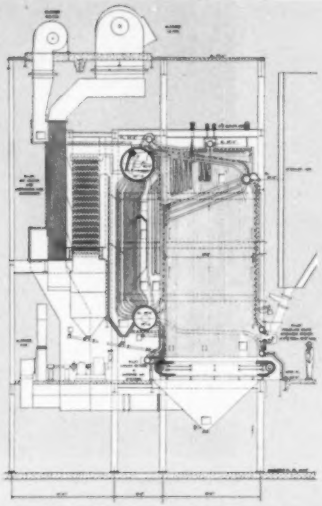
► GUIDED MISSILES carry a secondary source of power for running vital elements, such as stabilizers, air surface and guidance controls, during their supersonic flight. AiResearch Manufacturing Co of Los Angeles announces the completion of an auxiliary power package using a tiny 60,000-rpm axial-flow gas turbine.

About the size of a milk bottle, the power package produces enough energy to operate all the lights, hoists, air outlets and other equipment needed in an automobile super-service station. The tiny plant includes a partial-admission gas turbine, reduction gearbox, 12,000-rpm induction generator and a gear-type hydraulic pump. Instead of a compressor, the turbine uses a gas generator for a source of pressurized power gas. Once ignited, the explosive-like fuel generates hot gas under pressure very rapidly. The turbine wheel drives both electric generator and hydraulic pump.

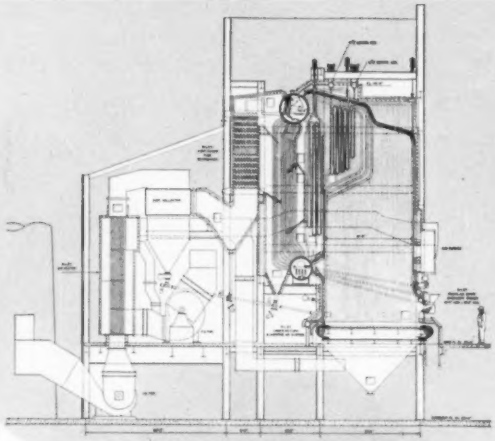
The tightly packaged unit, exclusive of the gas generator, measures six inches in diameter, 11 inches long, and weighs 16 lb. The gas generator may be even smaller, depending on length of operating time needed. Current performance figures are 2.5 gpm of oil at 1500 psig for the pump, and 750 watts of 400 cycle, 115/208 v, 3-phase alternating current for the electric generator.

Making minor changes in turbine nozzle and gas generator can double the hydraulic pressure and raise electrical output to 1300 watts. Guided missile operation imposes limits on design in respect to rapid altitude change, severe acceleration, shock, vibration and radio noise. The induction generator uses neither brushes nor slip rings, which helps to meet operating limitations. Generally rugged construction makes the package suitable for auxiliary service in guided missiles.

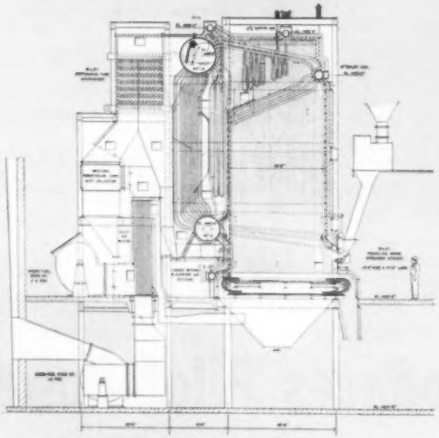
A few outstanding Spreader-Stoker



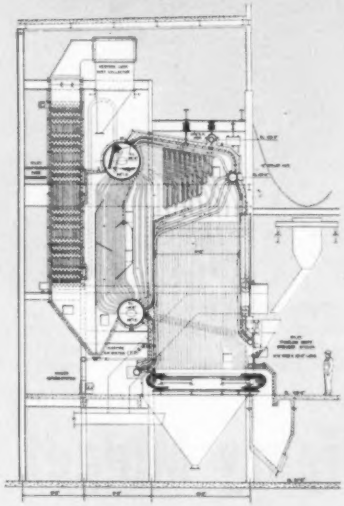
CARBIDE & CARBON CHEM. CORP., Whiting, Ind.
Three 165,000 lbs./hr. 1000 psig 790°F.



CORN BELT POWER CO-OPERATIVE, Humboldt, Iowa
125,000 lbs./hr. 700 psig 825°F.



THE CLIFFS POWER & LIGHT CO., Ispheming, Mich.
100,000 lbs./hr. 450 psig 750°F.



IOWA-ILLINOIS GAS & ELECTRIC CO., Iowa City, Iowa
60,000 lbs/hr. 500 psig 740°F.

TRADE MARK REGISTERED

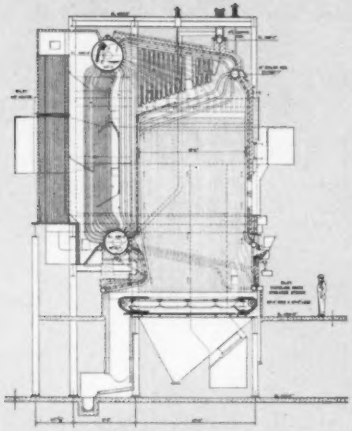
RILEY

STOKER CORPORATION, WORCESTER, MASS.

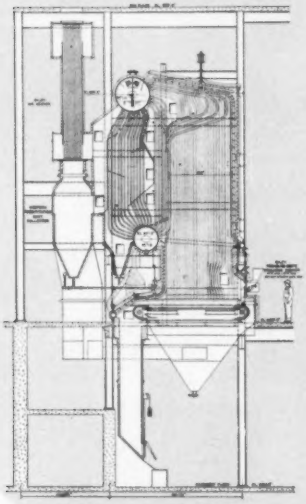
Boston New York Philadelphia Washington Buffalo Pittsburgh Cleveland Detroit Chicago
Cincinnati Atlanta New Orleans St. Louis Kansas City St. Paul Tulsa Houston Denver
Salt Lake City Los Angeles Portland Seattle

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS

fired RILEY Steam Generating Units



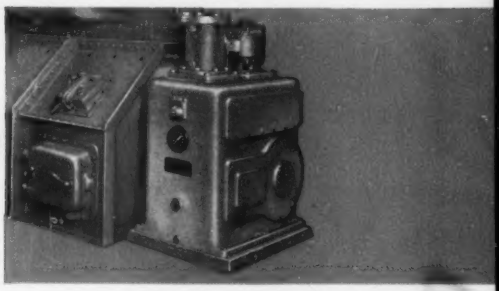
EUGENE WATER & ELECTRIC BOARD, Eugene, Ore.
175,000 lbs./hr. 700 psig 835°F.
Waste wood is also burned.



OHIO EDISON CO., Akron, Ohio
90,000 lbs./hr. 250 psig

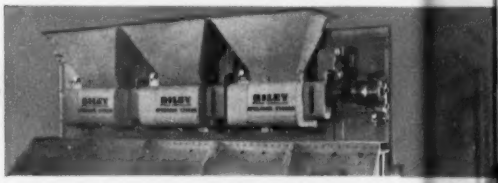
Compare the Construction of these Important Parts . . .

Grate Drive



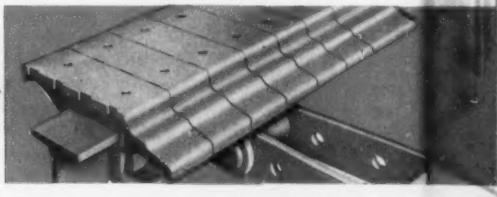
Riley uses a hydraulically driven ratchet drive, completely enclosed and automatically lubricated. This simple rugged drive operates with practically no maintenance and is not susceptible to damage in case of grate obstruction. No sprockets, chains or speed reducers are required.

Feeder Distributor



The use of an adaptation of the Stephenson link mechanism provides complete speed control. The entire mechanism is enclosed and splash lubricated. The overthrowing distributor gives uniform longitudinal and lateral distribution and prevents damage and outage caused by wedging of foreign materials between distributor and housing.

Grate Surface



The grate surface is made up of small grates, only 2 inches wide by 6-inch pitch, mounted on carrier bars. The use of small grates assures low maintenance and long life by providing adequate cooling and the elimination of warping and cracking. Uniform air distribution is obtained.

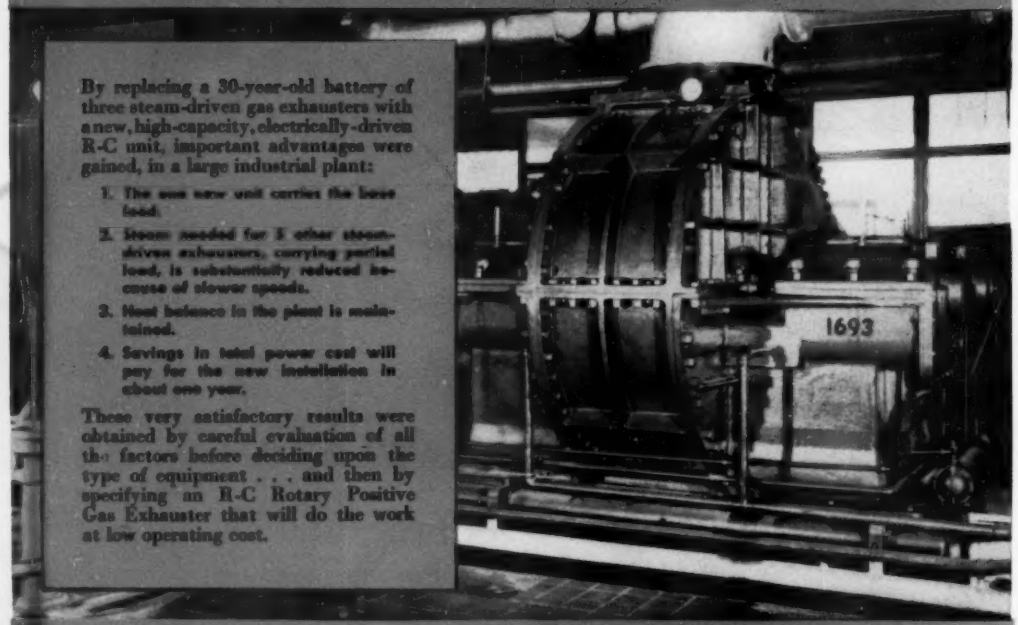
A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in your power costs

COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

NEW R·C EXHAUSTER
pays its own way



By replacing a 30-year-old battery of three steam-driven gas exhausters with a new, high-capacity, electrically-driven R-C unit, important advantages were gained, in a large industrial plant:

1. The one new unit carries the base load.
2. Steam needed for 3 other steam-driven exhausters, carrying partial load, is substantially reduced because of slower speeds.
3. Heat balance in the plant is maintained.
4. Savings in total power cost will pay for the new installation in about one year.

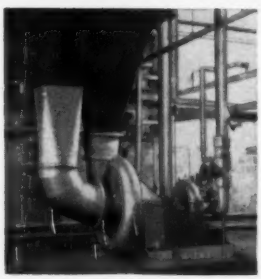
These very satisfactory results were obtained by careful evaluation of all the factors before deciding upon the type of equipment . . . and then by specifying an R-C Rotary Positive Gas Exhauster that will do the work at low operating cost.

Type RCSH Rotary Positive Gas Exhauster, driven by 400-hp synchronous motor. Capacity, 20,600 cfm.

Even though your equipment to handle gas or air may still have years of life, it may be sound economy to replace it with modern, efficient, R-C units of the right type, size and drives to best meet your needs. Our engineers will help you analyse your problem and make unbiased recommendations of either Rotary Positive or Centrifugal equipment, depending upon your specific conditions. This *dual choice* is an exclusive R-C advantage.

With capacities from 5 cfm to 100,000 cfm, R-C units can be closely matched to work requirements, for dependable, economical performance. At Roots-Connersville, almost a century of blower building experience is at your service, without obligation.

ROOTS-CONNERSVILLE BLOWER CORPORATION
151 Powell Avenue, Connersville, Indiana



Single-stage, Type OIB Centrifugal Blower in food processing plant. Steam turbine drive; capacity 12,000 cfm.

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

"I Know My Job"

Today you understand your job from A to Z, but will you understand it tomorrow? It's a fair question. See what happened to locomotive engineers:

In 1935, diesel locomotives on all of America's Class 1 railroads totaled only 117 units. That was only a drop in the bucket, so the average locomotive engineer or maintenance man didn't let the newcomer worry him—saw no threat to his proud position as a railroad man who knew his stuff.

But see what happened. Today more than 14,000 of these diesel units are in service. And out of every twenty new locomotives purchased, nineteen are diesels.

Think what this revolution meant to the men who prided themselves on knowing every nut and bolt on a steam locomotive—and not much else. In the long run they had to swallow their pride, go back to kindergarten and learn the ABC's of diesels and electricity. Some few saw what was coming, dug into the new arts and got ready ahead of time.

In the power field, too, you have to keep humping to hold your own with technical progress. And here it's not simply a case of a new prime mover, but of scores of big and small developments. Some are brand new; some have been gaining acceptance for years; and some are just around the corner.

The real old-time engineer, with his corliss engine, may wake up any day with a diesel generating set, a turbine, or perhaps a rectifier working on purchased ac.

Another engineer, with old electric elevators, faces a big modernization job and some brain-twisting control circuits. Others will have to handle complicated circuits in combustion and air-conditioning controls. More and more these will involve electronics, something Dad never had to bother about.

In many plants higher steam pressures will force new standards of scientific water conditioning. Radically new ways to burn coal are coming in. Smoke and dust have become political targets, so clean stacks will be another responsibility.

Tomorrow's high-paid workers will demand new standards of comfort, safety and sanitation, and the engineer must know how to give them what they want. Meanwhile management's pressure for lower costs will force more engineers to adopt modern business methods, to plan and manage such functions as maintenance and lubrication, and substitute power tools for hand labor wherever possible.

The list could go on all night, but the point should be clear. All in all it's a whale of a big order for the engineers of tomorrow—also their big opportunity.

Some of today's engineers won't make the grade, for lack of ability, guts or foresight. Others will meet this everlasting challenge by constant study. Study is work. It's also fun when you learn how and get the habit.

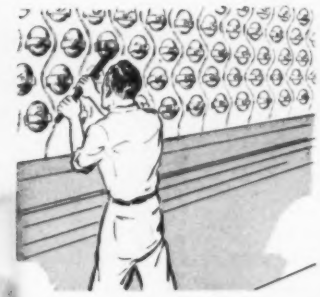
And it's even more fun to bring more money home on pay day and win the many rewards of all-around competence in handling the people and the technical gadgets of this machine age.

Phil Swain

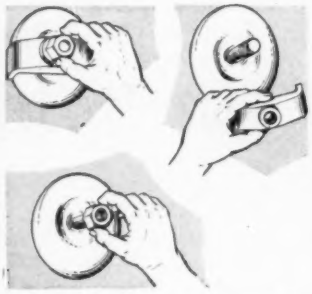
OPERATORS' NOTEBOOK 43

Now You Can Slash

THESE STEPS SHOW HOW

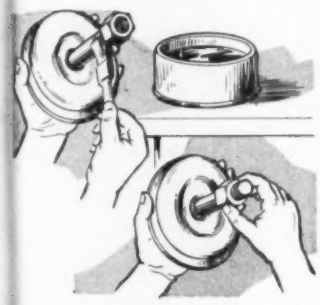


1 Save expensive labor by doing one thing at a time. Start at top row and loosen all of the nuts with special wrench



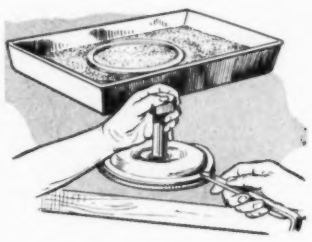
2 Next operation on each plate is to remove nut, take off dog and screw nut on a few turns, to protect threads

3 Start at top row again and knock in each plate with one good smack near top of nut. Work fast, no lost motion



7 Brush graphite and cylinder oil mixture over threads. Run nut all the way down and out to within a few threads

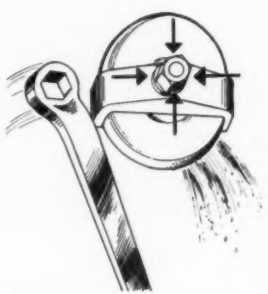
8 Fill bucket with water and dump soft handhole gaskets in it. Water swells gaskets and helps the graphite stick



9 Work powdered graphite over wet gasket. DON'T USE OIL—IT HARMS BOILER'S WATER SIDE. Place on gasket

13 Start from top and smack each nut from four sides to help plate find its right position. Then tighten nut

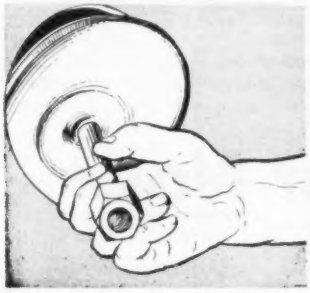
14 Fill boiler slowly with feed pump. As boiler fills, take up on each leaky plate just enough to stop leak



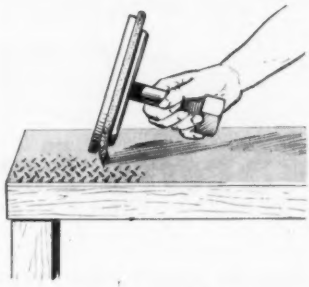
15 If plate still leaks, loosen nut and smack four sides, then tighten. If leak won't stop, pump water below plate

Handhole Plate Time

By **STEVE ELONKA**, *Associate Editor*

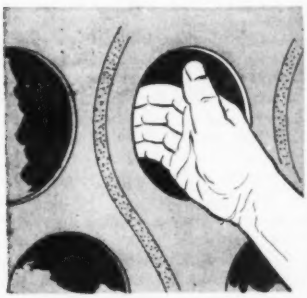


4 Now grab each plate's stud with one hand, turn plate slightly, remove from hole and throw into one pile on floor

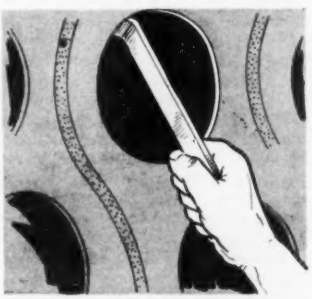


5 Grab plate by its stud and slide on piece of floor plate, turning plate so gasket is loosened all around outside

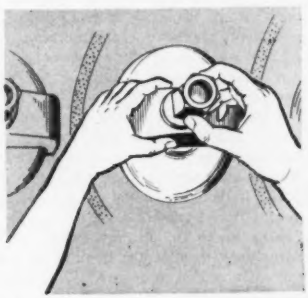
6 Scrape pieces of joint and scale from sealing face of plate. Do only this operation and stack plates in neat pile



10 Next run fingers around on inside of joint surface. This is important because foreign matter can cause leak

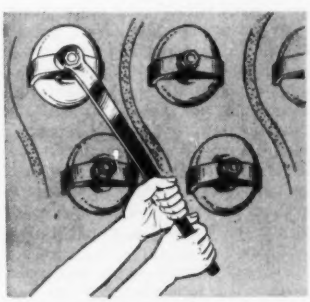


11 Scrape broken gasket pieces and other obstructions off with bent scraper. Don't overlook any dirty joints

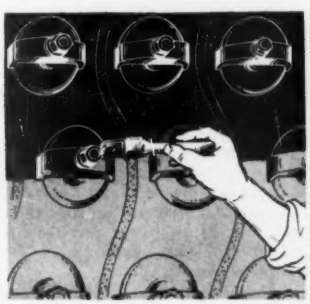


12 Replace plate, dog and nut. Hold plate so joint is centered and against header. Screw nut to hold plate

16 Remove leaky plate and examine joint for obstruction—also plate might be warped or corroded. Replace it

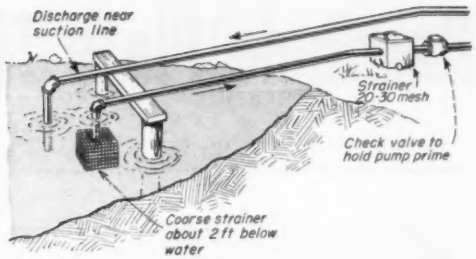


17 With boiler full and feed pump holding pressure on boiler, go over all handhole plates and tighten nuts



18 While raising steam, paint headers, plates, dogs, nuts and studs with Bunker C fuel oil to prevent rusting

Pond water knocked out diesels often. But Mac called C Morgan Jones, who went into high gear so quickly that.....



SUCTION AND DISCHARGE close together with right strainers help engine reduce scaling by cutting down heavy sediment

...Scale Scats Fast Now

► "YES," MAC SAID, "Joe's put the hex on the big diesel again. A piston seized up, the connecting rods bent and the liner scored badly. There are score marks on other liners, too."

"Do you know," Mac continued, "that every time Joe's corns ache, something goes wrong with this engine? Now I ask about his corns every morning, so I know what to expect. If they ache for a few days, I get ready for trouble. Just caught her in time this morning."

I looked at the engine's log book. It was a sad story. Through the pages, notations read: "No. 4 piston seized; No. 3 liner scored; new rings put in No. 5, pulled No. 1 liner (hard to pull) and replaced same."

Mac broke in, "Funny thing, Joe's corns don't trouble him in summer. It's the same with the engine." That gave me a clue.

Joe was shuffling along with his broom and barrow. I asked about his corns. "Not too bad today. It's only when it's going to rain that they nearly kill me," he said.

Open Pond. In this plant they use raw cooling water from an open pond, some 150 ft away. The auxiliary engines give no trouble. They have enclosed cooling systems. The big engine is cooled with water pumped directly from the pond.

I ran my hand around a pulled liner's waterside. It was thick with layers of scale. I asked Mac how often he cleaned out the water jackets. "No need to do that," he told me, "we've got plenty of good fresh rainwater in that pond. You can't beat that for engines."

I showed him the scaling and asked if he had trouble with the auxiliaries. He admitted he hadn't.

I checked the line back to the pond. There was a coarse suction strainer in the pond. It was corroded and patched with chicken wire. The pond was obviously an old limestone quarry. It wasn't deep and weeds and mud shelved down toward its center. It was nothing more than a shallow weed-grown pit.

Cause of Scale. There was Mac's trouble. Every time it rained hard (and Joe's corns ached), the rain stirred the shallow pond water. Then fine mud circulated through the engine. On hitting the hot liner walls, the mud stuck there. So mostly clear water returned to the pond, which was a long distance from the suction intake. Placing the discharge closer to suction would have helped.

Pulling Liner. Pulling the damaged liner was tough because of bonding action between scale and rust deposits. I advised not to let scale collect over 1/32 in., or at most, 1/16 in. And then only if engine had to be kept on the line. We replaced the liner. I showed how to clean the engine without tearing it apart and chipping and scraping.

Acid Cleaning. First, from maker's handbook, we found how much water jackets held. Then we made enough solution to fill the water spaces with one part muriatic acid (hydrochloric) to two parts water. We drained the engine and blanked off cooling-water supply line; filled engine with solution and let stand until all bubbling ceased. It bubbled furiously when poured in, so we listened by placing an ear against the jacket.

You can remove heads and make separate jobs of heads and blocks. Circulate cleaning solution with a hand-pump, drawing from top and returning to bottom. Circulate at least twenty minutes. Then flush with clean cold water.

Renew the cleaning charge with five parts water to one acid. Keep in engine for about one hour. Drain and flush engine thoroughly and refill with a hot lye solution (two pounds of lye to one gallon water) and circulate for about 90 min. This kills pockets of acid solution that didn't drain out. Flush several times with cold water.

Caution: Remember that acid attacks engine metal as well as scale, so circulate acid for only as short a time as necessary.

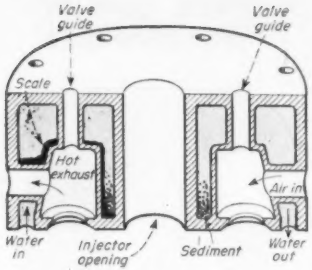
If scale is thin, make solution five to one. Fill engine and let it stand overnight. After draining, flush well with clean water.

If no acid, fill engine with a fairly strong solution of caustic soda and place electric immersion heaters in cooling system. Heating solution helps caustic sodas do a cleaner job.

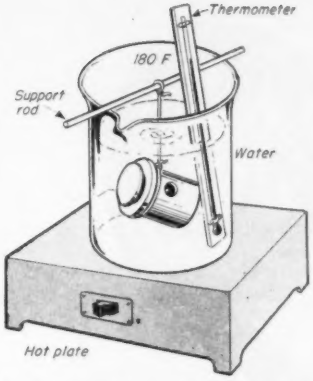
One operator told me that my cleaning acid thinned his water passage walls in places to dangerous limits. But I found the real culprit was electrolysis. So install zinc electrodes in engines to absorb stray electric currents. Electrolysis attacks marine engines especially hard.

More About Scale. But where does scale come from? Cooling water often shows no sign of sediment in suspension. Take a water sample and get it analyzed. If it shows a high mineral content, it might be cheaper to install heat exchangers, using pure water (distilled preferably) in engine and raw water for cooling. Or use water softeners if you can't install exchangers.

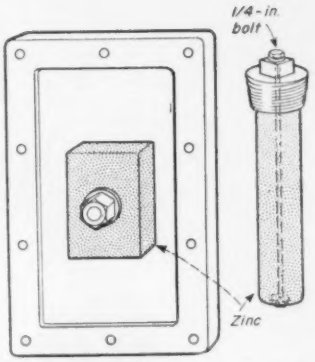
Scale prevents cylinders' heat from being carried away by cooling water. Scale is one of best insulators known.



CYLINDER HEADS get badly scaled about hot exhaust valve, then head cracks



CHECK THERMOSTATIC-VALVE operation by heating in water to right temperature



ZINC PIECES fastened to jacket-water inspection doors or plugs save metal

PASTE THIS INFO INSIDE YOUR HAT . .

1 Clean jackets and heads often and easily with acid without tearing down engine

2 Scaled cylinder heads crack castings, shear studs and warp liners

3 Rubber hose on suction collapses in time and engine starves for cooling water

4 Check thermometers, as shown, to make sure they read right

5 Paint stripe on cylinders with copper mercuric iodide if no thermometer's handy

6 Use 20- to 30-mesh strainer on suction line if cooling water is from pond

7 Keep independent pump running after stopping engine until discharge and suction temperatures are nearly even

Remember that cylinders' heats range from 100 F to 1100 F. On the power stroke, at least half of oil film on liners is burned off. Piston seizes when all oil film is burned because of poor cooling effect.

Then heat leads to unequal expansion, warping and sometimes fracturing cylinder-head studs. Heat also causes liner's flange to expand and exert tremendous pressure against the head. If the gasket doesn't blow out, then studs often shear off.

If you have trouble with shearing studs, check your cooling system well.

Caution: If studs break a few times, don't just replace with larger ones. If stronger studs hold, the cylinder head might crack.

Overheating. Cracked cylinder heads are usually caused from cooling-water failure. Also from scale or steam pockets in head passages because of too little coolant flow. Flow is retarded often by scale obstructing passages. New cylinder heads cost money. It's cheaper to inspect and schedule cleaning than it is to pay repair bills.

Another overheating cause that stumps new operators is defective thermostats. In many engines using enclosed cooling systems, thermostats keep cooling-water temperature within set limits. If the thermostat fails to open, engine gets hot and away goes liner or piston, perhaps both.

Paint Indicators. If no thermostatic control, or warning system, buy copper mercuric iodide at paint store. Paint a broad band from each cylinder head down side of engine. This compound is an excellent heat indicator. Up to 130 F, it's a bright red; at 135 F it's dark red; at 145 F it's maroon; at 155 F it's light chocolate; at 160 F it's dark chocolate; at 190 F it's almost black and at 215 F, it's black. When engine cools, colors reverse as temperature drops. Another heat indicator paint is silver mercuric iodide.

These paints give some warning and are better than nothing. But remember that heats inside jackets are higher than shown on outside. Also use these paints on shafting or overhead bearings that are hard to get at.

Try to keep engine's cooling water at 165 F to 175 F. Of course this depends on engine speed and overload. Also the general conditions of cooling-water system.

If your cooling-water discharge is over 180 F, check cooling-water pump, fresh-water pump, and water circulation through heat exchanger. But don't let your engine run too cool. This makes black exhaust because of low temperatures preventing good combustion. Then you have more trouble cleaning valves, cylinders, pistons, etc. Low cooling-water temperatures can also cause engine to stall.

Suction Strainer. When putting in a cooling-water line from pond, sea, etc., use strainer of not more than 20 to 30 mesh. Make total open area of screen at least 15 times pipe area. If water's from an open pond, use large intake pipe, depending on engine's size. Slower water velocity through pipe carries less grit, mud and dirt to engine.

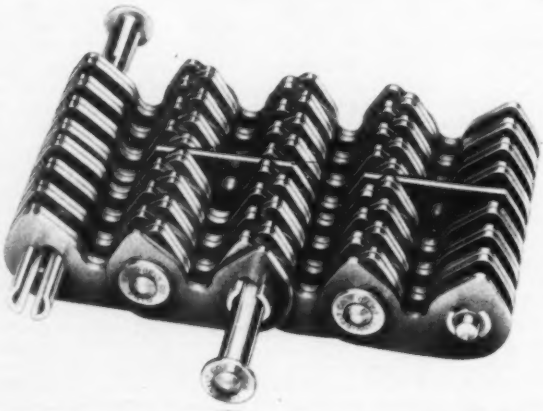
Don't use rubber hose between engine and water supply. Why? Because with time, rubber hose becomes weaker. Then pump suction gradually collapses hose and pump won't lift full water supply.

It's okay to use a short section of rubber hose between engine and suction line (at point where it's anchored). It absorbs vibration and prevents line fractures. But keep it short.

If engine's fitted with independent pump, keep it running after shutdown until water's inlet and discharge temp are only 5 to 10 F apart. If you don't, steam pockets form in water passageway's hot areas, especially in heads. That causes fractures, or at least scaling.

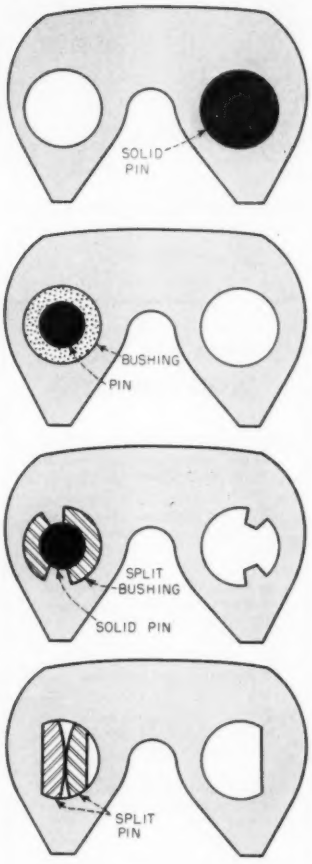
After giving Mac this information and making changes outlined here, I haven't heard from him. And I'm told he never asks about Joe's aching corns.

1 Sprocket center distance must be adjustable to take up slack. One good way is with an adjustable base for motor. Channel-iron slide rails work well too



2 Modern-type chain with middle guide that fits in slotted sprockets. Removable case-hardened bushings extend across width of chain; they're cinch to lubricate

TYPICAL JOINTS FOR SILENT-CHAIN LINKS



3 Joints take greatest wear. Early pin type at top; improved joints below

Buying Silent Chain?

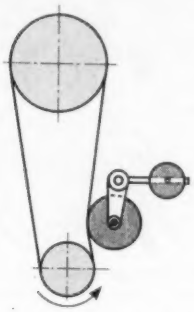
BY JIM SPARKS,
Hibbing, Minn.

What it is . . . types . . . details of construction . . . practical limits when using . . . selection guide . . . speeds . . . alignment . . . lubrication . . . and maintenance. All wrapped in 2 pages

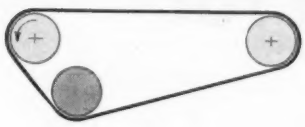
► THEY'RE called "silent" chains because they operate quieter than other type chains. But they're not silent! They fit well into the power-transmission field where a positive drive is called for. Best speed ratios for silent chains are from 1:1 to 6:1. Large ratio drives are costly in both first cost and maintenance compared to a double-reduction, which is something to think about.

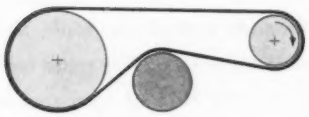
How They're Made. A silent chain is made from a series of flat leaves or links, Fig. 2. Leaves are tooth-shaped at each end. Pins slip through holes at end of each link. When in use the links roll around the pins. Note that as the chain rides on the sprocket a rolling rather than flat-surface contact occurs. This type construction limits vibration of chain parts between sprockets. Hence

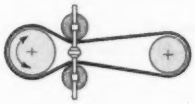
SLACK TAKEUP ON VERTICAL AND HORIZONTAL DRIVES



4 Avoid vertical drives. But if used keep sprockets a little off vertical

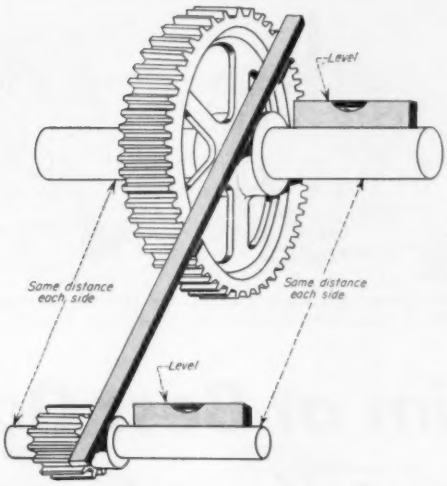




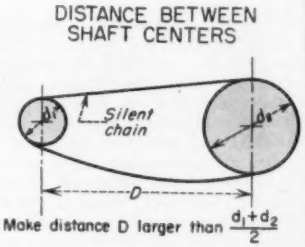


5 Typical chain-adjusters. With speeds over 1300 fpm use case around chain

HOW TO CHECK CHAIN ALIGNMENT: 3 STEPS



6 Alignment check: (1) Same distance between shafts at points shown, (2) Shafting level, (3) Sprockets in alignment



7 If you make center distances less than above, sprocket teeth will hit

the term, silent chain, has been adopted.

Most wear in a silent chain takes place at the joint. In the early silent chains the joint was made with a solid round pin that passed through holes punched in each link, top Fig. 3. Each link then bore directly on the pins resulting in fast wear. Both the links and pins wore by rubbing action from chain wrapping around the sprockets. The three lower links in Fig. 3 show improvements on simple-pin design.

You can get silent chain in pitches from 3/15 to 3 in. Incidentally chain pitch is the distance between joint-centers of each link. Chains are available to transmit a fraction of a hp to several thousand. They can be operated at speeds up to 5000 fpm. But it's smarter to hold speeds down to between 1400 and 3500 fpm. You'll generally find it best to use roller rather than silent chain where you dip below 1200 fpm.

There has been little standardization in the field of silent chain sprockets. Each manufacturer has more or less carried out his own design and his own ratings. When selecting sprockets use 17 teeth as a minimum number in pinion; but best results are with 21 or more.

Where possible use an odd number of teeth in both sprockets. Chains are generally furnished with an even number of pitches. Combination of odd teeth and even pitch chain increases life of drive because same point on sprocket and chain will not mesh on every time around to cause uneven wear.

Shearing pins are sometimes used for fastening the sprocket to protect equipment against overload. After an overload has sheared the pin it's simple enough to insert a new pin and you're all set again.

Selection. We're not going to tell you how to select chain size. You'll find all the dope needed on this subject in any of the leading manufacturers' catalogs. They've tables and recommendations galore.

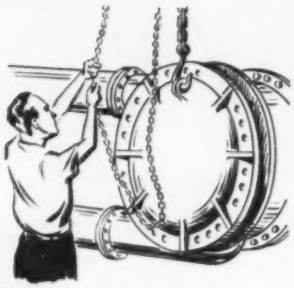
But where you run into special drives that can't be matched by the catalog-selection methods drop a note to the chain manufacturer. To save time include the following in your first letter; hp to be transmitted, rpm of driving and driven shafts, diameter of faster-moving shaft, distance between shaft centers, position of drive and space limitations, type load, steady, pulsating, etc.

Installation and Maintenance. As in all transmission installations, a top-notch alignment job is necessary, Fig 6. This is especially true for silent chains in the high-speed range.

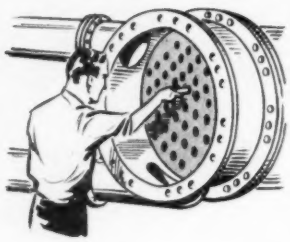
Some silent chains are designed to operate in one direction only. When you use this type chain make sure the arrow on the side of the chain points in the direction of chain movement.

Casings are used around chain drives to keep out dirt and keep in lubricant. Of course there's the safety angle too. And talking about lubrication, select oil viscosity on the basis of ambient temperature. Where the ambient runs between 20-40 F use an SAE 20; for 40-100 F hold to SAE 30; use SAE 50 where the ambient temperature is high and hangs between 100-140 F.

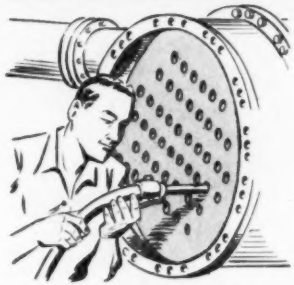
HOW TO CLEAN YOUR CONDENSER TUBES



REMOVE condenser waterbox covers from both ends of unit, using a chain fall



PUT cloth-inserted rubber plug or nylon-bristle brush in tube you wish to clean



DRIVE rubber plug through tube with air pressure or push brush rod through tube

Aim at Best Output for Centrifugals...

. . . by cleaning tubes at right intervals with proper tools, balancing pressure drops through multiple units on the same load and adjusting speed or damper for the needed temperature

By JAMES G MANNING
Manager of Equipment Operation, Carrier Corporation

► IF YOUR CENTRIFUGAL refrigeration job is the usual one you'll clean condenser tubes once a year. But some jobs need tube cleaning more often; others less often. A lot depends on water condition. Let experience guide you. If you ever have doubts, clean tubes at least once a year.

Cleaning Tools. Spiral nylon bristle brushes are best. Steel or bronze brushes can scratch copper-tube surfaces. If tubes have soft deposits special cloth-inserted rubber plugs of proper size may be used. Plugs are blown through each tube by air pressure applied by nozzle and washer at one end. Sketches, *above*, show how to clean tubes with plugs.

Where tubes are completely covered with scale, chemical cleaning does best job. Machine builder will recommend firms in your area who can do this or supply the needed materials.

Seasonal Cleaning. Always clean tubes on a new machine after the first season's operation. This removes scale and other materials that may have entered from new piping. Flush brine and condenser-water piping before putting any system into operation after seasonal shutdown. Take care to prevent rust and scale in condenser and brine systems by water treatment and painting.

If your seasonal overhaul includes acid cleaning of tubes vent high points of condenser and cooler so solution contacts all parts and any gas generated escapes to atmosphere outside machine room. Don't allow any sparks or flames around machine during acid cleaning nor for some time after it is back in operation. See machine builder for exact time to be allowed. Paint water boxes and tube sheets after each cleaning.

Tube Renewal. If you treat condenser and cooler tubes right you'll have few failures during the life of the centrifugal unit. But if a tube fails and you must remove it, roll in a new one.

In an emergency when a tube must be taken out and there are no spares on hand you can use stub tubes as on *opposite page*. Refrigerant temperature must be above 32 F at all times; if not, don't use stub tubes.

To make stub tubes braze plugs into one end of pieces about 8 in. long. Remove damaged tube and roll plugged pieces into tube sheet. They are easy to take out later when machine is shut down for overhaul. If a tube-sheet hole has been damaged, preventing roll-in of another tube, a threaded plug may be used to close hole. Once this plug is in, tube can never again be used in hole.

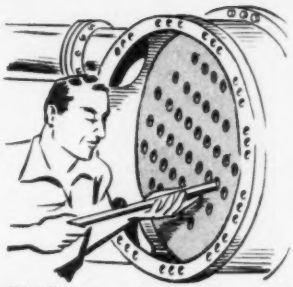
Water Flow. When you have two or more centrifugal refrigeration units of different size on the same load, output has to be balanced for best economy. To do this you must adjust brine and water flow rates through each unit so they are proportional to its full-load rating. Let's solve a typical example to see how it's done.

Example: A plant has one 300-ton and one 500-ton centrifugal refrigeration unit. Total brine flow is 1600 gpm, condenser-water flow 2000 gpm. How much brine and water must flow through each machine for 800-ton load?

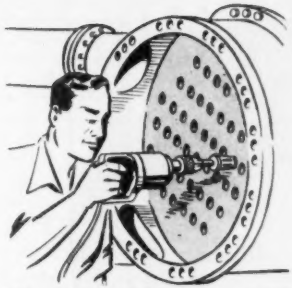
Solution. Brine flow, gpm per ton, is found by dividing total flow by total plant capacity, or $1600 \div 800 = 2$ gpm per ton. Also, condenser flow is $2000 \div 800 = 2.5$ gpm per ton. Flow rates should then be: Brine through small machine = 300 tons × 2 gpm per ton = 600 gpm; through large machine =

EMERGENCY PLUG FOR TUBE SHEETS

BRAZE plug into end of 8-in. length of condenser tubing. Don't pinch the tube

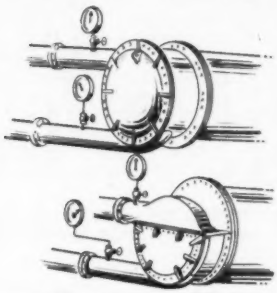


REMOVE leaky tube carefully so tube-sheet hole isn't damaged. Clean sheet

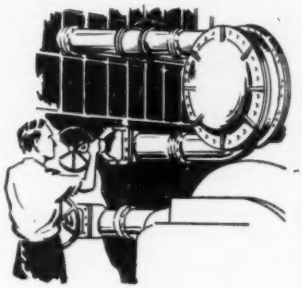


ROLL stub tube into place. Use only when Freon temperature is always above 32 F

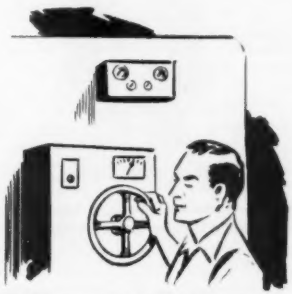
BALANCE UNIT OUTPUTS TO SAVE POWER



PRESSURE-GAGES are on the condenser and cooler for finding drops in units



ADJUST condenser and brine flows so they are proportional to unit ratings



AFTER flows are adjusted, vary machine speeds or damper positions as needed

$500 \times 2 = 1000$ gpm. Condenser-water flow is $300 \times 2.5 = 750$ gpm for small unit, $500 \times 2.5 = 1250$ gpm for large unit.

Meter quantity with flowmeters or use pressure gages on inlet and discharge of condenser and cooler. Gages, as in diagrammatic sketch *above*, should read only drop across cooler or condenser, and not include drops through any pipes, valves or fittings.

Where pressure drop isn't more than 15 psi, a 36-in. mercury U tube may be connected across coolers and condensers of one machine after another and pressure drops read and recorded.

It's tough to figure pressure drops for most jobs using two or more machines. So always have manufacturer do this right after machine installation. Mark brine and condenser-water valve positions for various loadings of the centrifugal unit. Then when operating in parallel at any load adjust valves to suit. Shut off flow through idle units.

With brine and condenser-water flow adjusted like this all you need do is vary machine speeds or damper positions so temperature difference between entering and leaving brine on all coolers in operation is the same. You can also use temperature differences on condensers as a guide. Plant is then operating most efficiently since each machine carries its share of load.

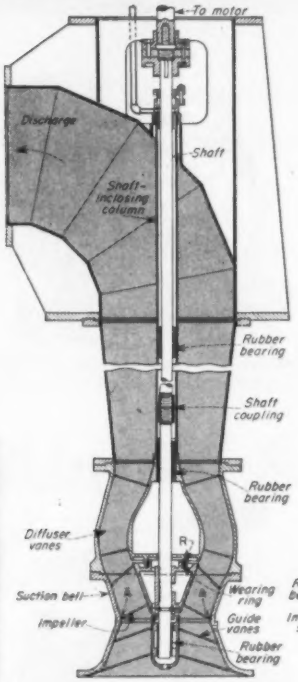
Adjust *each* machine to a higher output when load increases; decrease output of *each* machine when load falls. Always try to keep temperature differences alike. When load goes down so do temperature differences across coolers and condensers. Study your plant to see when machines may be shut down and load transferred to remaining units by increasing the output of each.

Automatically controlled machines behave as above if each controller is set for same brine temperature, and cooler and condenser flows are properly balanced. Where you have several centrifugal units of identical ratings you needn't balance water and brine flows. All valves on any unit may be wide open when it is operating. Divide load equally between all units by speed or damper adjustments.

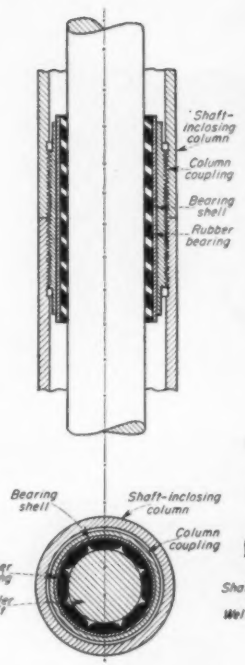
Holding Output. This article gives only general hints for getting best output from your centrifugal refrigeration units. Since machine designs vary remember that you can get best help with operating problems from the builder. He's a specialist who knows what his machines can and cannot do. He is always glad to answer any questions that might come up about his unit.

A good point to keep in mind about centrifugals is that the erecting engineer is probably more familiar with your job than anyone else. He has been trained to instruct you in machine operation, maintenance and overhaul. Make use of his services.

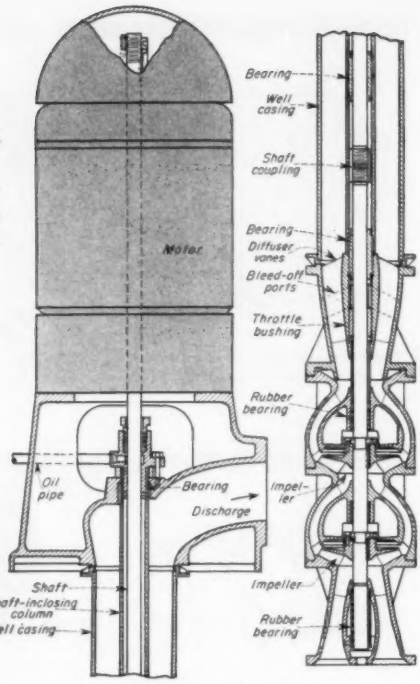
EDITOR'S NOTE: *This concludes the series on centrifugal compressors by Jim Manning.*



1 Cross section through single-stage circulating-water propeller-type pump



2 A rubber bearing in a shaft-enclosing column as used on a propeller pump



3 High-head multi-stage pumps may have throttle bushing bleed-off port

Hot Maintenance Tips for

Though of simple design propeller pumps need attention. Here you are told the causes of troubles, their symptoms and how to maintain these pumps to get long and reliable service

By **LEWIS J DAWSON**, *Field Engineer*
Cameron Pump Division, Ingersoll-Rand Co

► THE WIDE USE of vertical propeller pumps for circulating-water and plant-water services gives plant maintenance men some new problems. In the higher capacities these pumps may be bulky but their parts are relatively simple and require no special tools. Fig. 1 is a cross section through a single-stage circulating-water propeller pump.

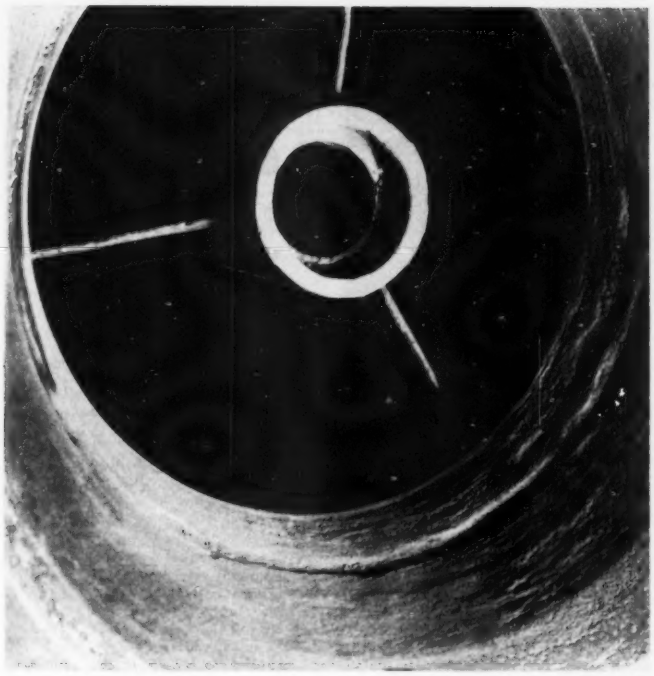
Shaft wobble indicates the need for an overhaul at the stuffing box. Wobble or whip of the shaft at this box makes it hard to keep packing tight. Because of long shaft spans and liberal bearing clearance propeller-pump shafts never run dead true.

Vibration. When a propeller pump vibrates it indicates poor mechanical condition that may be caused by a motor out of balance or worn bearings. If the complete unit vibrates the propeller may be out of balance. Propeller blading damaged by a solid object drawn into the pump can cause sudden out-of-balance.

Water in Oil. On oil-lubricated inner-column pumps, if water backs up into the oiler, wearing rings at the top of the propeller are worn. On water-lubricated-bearing column pumps, wear may cause lubricating-water flow to increase to keep enough column pressure.

Shaft Wear. Depending on pump design, shaft-journal wear takes place on the shaft or on the journal sleeve when used. Where bearings run on the shaft as in Fig. 2, it may be possible to turn shaft sections end-for-end to get a new journal surface. When this cannot be done, journal areas may be built up by metal spraying. After spraying, grind the journal surface to a fine finish and check the shaft to make sure that it is straight. Replace badly worn shafts.

Shaft Couplings. How straight a shaft is, when made up of sections screwed together, depends on how square the shaft-section end faces are and condition of the shaft and coupling threads. Reface shaft ends that are scuffed or dented. Rechase damaged



4 This suction bell of a propeller-type pump has been pitted by cavitation, as indicated by the deep groove, and has been eroded by abrasives in the water

Propeller Pumps

threads and renew shaft couplings if in poor condition.

Bearing Wear. Check metal-bearing wear with micrometers. Make measurements at both ends of the bearing and in two planes, as wear is often bell-mouthed or elliptical. Replace bearings if wear is more than 2 or 3 mils.

Rubber Bearings. Because of the fluted surface and their resiliency rubber bearings cannot be checked with micrometers. A shaft-size plug gage or a test on an undamaged section of the shaft, will indicate the amount of wear.

Loose Bearings. A whipping shaft hammering rubber bearings may loosen the bond between the rubber and metal backing. Discard bearings in this condition. Silt getting behind the lining may force it against the shaft. Or the lining may come loose from its metal backing, and drop out of its holder, which is serious.

Metal Backings. Don't tack-weld metal backings of rubber bearings as the welding heat will separate the lining from the backing. Pressfit the bearings in their housings or hold them with setscrews.

Water Lubrication. Where parts of the rubber lining stick to the shaft journal and the lining bore is torn, the bearing has run without lubricating water. Water-lubricated column bearings require a continuous supply of clean water at pressure enough to push it down the column.

Grease or Oil. On grease-packed suction-head bearings run a supply line from the surface and regularly give the bearings a shot of grease. Once a day is not too often in dirty-water service, as the grease pushes out the abrasive dirt. Give oil-lubricated column bearings several drops a min from the oiler. Turn on oiler 15 min before starting the pump.

Propeller Blades. Bent or damaged propeller blades or pitted areas on them cause unbalance and, as a result, rapid journal and bearing wear. Kind of wear on the journals above and below the propeller give a clue to the amount of balance.

Propeller Balance. If the journals are worn evenly all around, the propeller is in good balance. If the wear is eccentric, but both journals are worn in the same plane, unbalance is mainly static. If the journals are worn out of round and the wear planes are 90 to 180 deg from each other, the unbalance is dynamic.

Wearing Rings. Where the propeller has a wearing ring on its hub, as at R, Fig. 1, check the clearance between this ring and the stationary casing ring. Replace them when they are worn more than 0.010 in.

Throttle Bushing. High-head multistage pumps may have a throttle bushing and bleed-off port above the last impeller, as in Fig. 3. If this bushing wears, replace it to prevent high-pressure water entering the column.

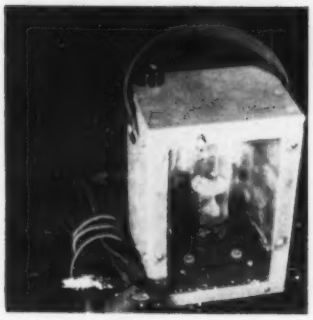
Suction Bell. When the bottom bearings and journals are badly worn, propeller-blade edges may contact and groove or scuff the suction bell. This type of damage can be corrected by a light cut to restore the original bevel.

Pitting and Erosion. Cavitation may cause pitting of the suction bell near the leading edges of the propeller blades, as at *A*, Fig. 1. Erosion caused by abrasive action of solids in the pumped liquid is a third type of wear. Fig. 4 shows a suction bell which has been attacked by cavitation (deep grooves) and erosion (general scoring). Cast iron, being a brittle material, is most subject to this type of attack. Bronze and stainless steel have high resistance to the effects of cavitation because of their better fatigue qualities.

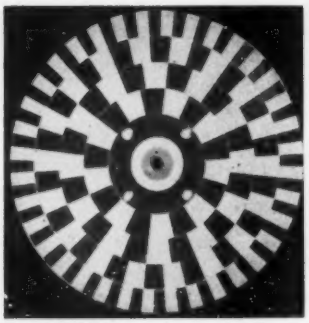
Metal Spraying. Pitted areas in cast-iron bells may be repaired by metal spray if care is taken to insure proper bonding. Replace suction bells that are badly eroded.

Check Propeller. After the pump's in operation and has been started and stopped several times, check propeller setting because the turning effort of the motor may further tighten the shaft couplings. If the propeller sets too high it can cause turbulence at the blade ends which will speed up suction-bell erosion.

Pump Runs Roughly. If, after overhauling a vertical pump, the unit is still rough, particularly if this happens off and on, check water surface for vortex formation. When the bottom of the suction bell is not far enough under water, air may be pulled into the impeller. Wood rafts on the water's surface or baffles attached to the pit's floor may break up the whirls where air enters.

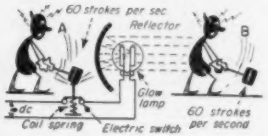


YOU TELL SPEED by first aiming light from this rig on disk mounted on shaft

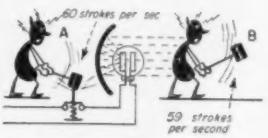


ONE OR MORE of the 4 rings shown will "stand still" when shaft hits set speeds

How A Strobe Tach Works



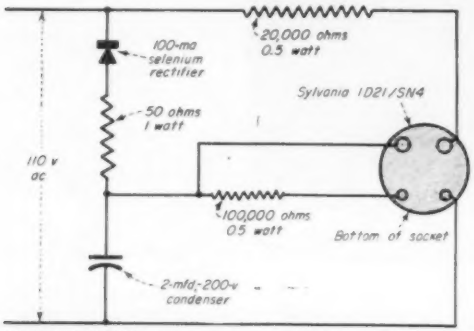
AMPY AT B will freeze as shown when in step with Ampy A



HE'LL MOVE BACKWARDS when his speed lags that of Ampy at A

If you can get a pulsating light source to keep in step with a repeating motion you've got a simple stroboscopic tachometer. The trick is to have the light flash (Ampy closing switch at A) timed so it "catches" B in the same place each time—top drawing. Ampy swinging the mallet, B, will appear to stand still if both A and B are moving at same speed. Then by knowing speed of Ampy at A we know speed of B.

HERE'S THE CIRCUIT HOOKUP



INTERNAL WIRING can be done with No. 18 or 20 stranded wire. Solder all connections. Note minimum wattage of resistors

Make Your Own Tachometer

It will cost about ten dollars to assemble this stroboscopic tachometer. Dale Kelly at Lehigh University, Bethlehem, Pa., found it paid off especially when checking gasoline engines

► YOU CAN BUY the case and practically all other parts of this strobe tachometer (let's call it a "flasher") from most mail-order radio supply houses. Only homemade part is the aluminum reflector. Bend this in shape of a half cylinder, then mount it behind the neon tube.

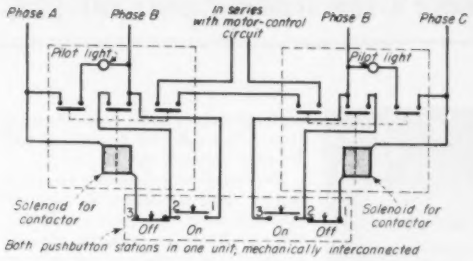
When you connect flasher to 110 v, 60 cycles, it gives off a short pulse of light each cycle. So if line frequency is exactly 60 cycles you'll get 3600 flashes every minute.

Making it Work. Mount disk on end of shaft whose speed you want to measure. Then aim the flasher at front of disk. You'll find that at certain speeds parts of pattern appear to stand still.

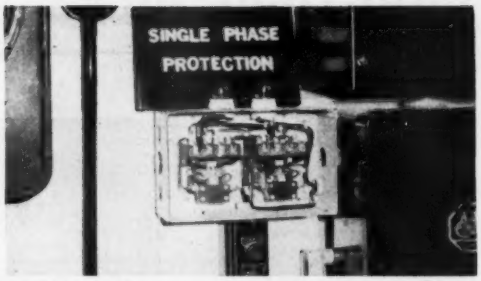
Outer ring has 36 white sections on a background. This ring will appear stationary at 100-, 200-, 300-rpm and so on. Next ring has 18 white sections and will "freeze" at 200-, 400-, 600- or any other *even* number of hundreds. Third ring has 12 white sections and will respond to 300, 600, 900 rpm etc. Ring nearest center has nine white and nine black sections and will appear to be standing still at any speed that is a whole-number multiple of 400 rpm.

With a little practice you can figure out shaft speeds by noting which of the four rings appear stationary. Until you get this practice use an auxiliary tachometer along with the flasher.

Where to Use. This strobe flasher has limited usefulness. It comes into play only where machines operate at speeds (*Continued at bottom of facing page*)



MAJOR STARTERS were hooked up as low-voltage relays



NOW MOTOR is tripped off when voltage fails on any phase

How I Protect Large Motors From Single-Phasing

► IF THERE IS a power failure in one phase feeding a 3-phase motor, the thermal overloads should trip after a short time. We didn't want to risk motor overheating so we hooked up two old magnetic starters to give us what we consider foolproof protection.

Now if any phase voltage fails, one or the other or both starters will trip out opening the main motor-control circuit. Voltage failure in phase *A* could trip out unit to left in sketch. Phase *B* failure will trip out both units. Voltage failure in phase *C* trips unit to right.

After any phase failure the "single-phase protector" must be reset using the button right below the device box. Since the starters used have an extra set of contacts we included a pilot light on each unit. After a phase failure the ON button must be pushed, closing in both coil contactors to complete the main control circuit.

R H SOMMERS *Pendleton, Ore.*

We Just Couldn't Get Spare Parts!

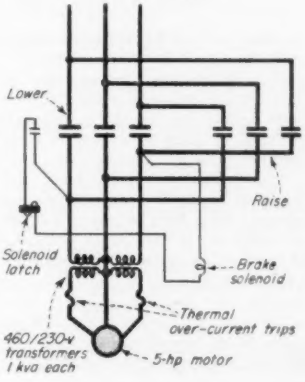
► DURING THE LAST WAR we couldn't get replacement limit switches for our plant hoists. This was serious since failure of upper limit switch meant motor kept lifting till the cable snapped. Then load would drop to the plant floor.

Hoists were seldom used. They were powered by 5-hp squirrel-cage motors fed from the plant's 460-v bus. The limit switch problem became so serious that we installed 460/230-v stepdown transformers that we had on hand. Since motor torque varies as square of voltage, motor horsepower was cut way down (¼ x 5 = 1.25 hp). However, we found the motors could still do the job needed.

Under the new low voltage, if a limit switch failed the motor would merely groan until the thermal trips took it off the line. Reduced voltage cut torque to the point where the cables would not be damaged on limit-switch failure.

This trick might come in handy again if industrial electrical equipment—especially replacement parts—becomes hard to get.

PAUL C ZIMKE *Oak Ridge, Tenn.*



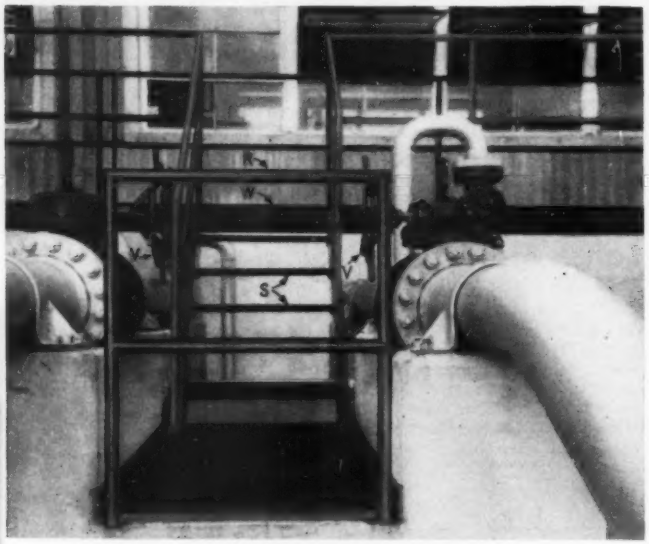
in even multiples of a hundred rpm. Good example is a routine dynamometer test of a gasoline engine. Another disadvantage is that it is no more accurate than the frequency of the power line from which it operates. But this frequency is usually close enough in most localities for any but the most exacting tests.

You'll find this tachometer more satisfactory (within its useful range) than conventional types because it responds immediately to very small changes from the speed wanted.

EDITOR'S NOTE: *You can buy a stroboscopic tachometer complete from several manufacturers that will give you speed of any machine directly on the instrument's scale. Simply plug into a nearby outlet and turn a knob on the strobe unit. This will vary the speed of the light flashes. When the flashes are in step with machine speed, the machine will appear to stand still. You can then read the correct speed on the instrument's scale.*

A stroboscopic light source is also handy when studying a moving machine. By adjusting the light flashes machine will appear to stand still.

PRACTICAL IDEAS... *here's the trading post for your*



PUTS SAFETY IN VALVE OPERATIONS

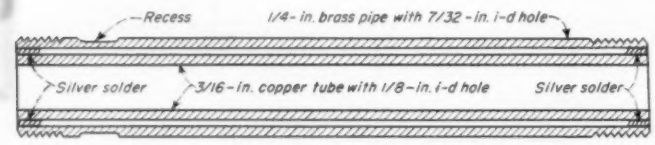
TO MAKE IT SAFE for operators to open and close main-line valves outside a gas-compressor plant one company handled the job as in the photo. The concrete foundations for the valves were designed so that an expanded metal floor could be put between them.

A short flight of stairs, *S*, leads from the main walk, *W*, down to the expanded metal floor. A safety rail, *R*, of welded 1½-in. pipe at the outer end of the floor keeps operators from falling off end and injuring themselves.

When the operators stand on the expanded metal floor the valve wheels, *V*, are at the right height for easy operation. The valves are located so that one can be operated and then the other by simply turning around.

With one main on either side of the operating platform and the welded-pipe railing protecting it there is no danger to operators, even in bad weather.

ELTON STERRETT *Houston, Texas*



DOUBLE TUBES STOP PIPES BREAKING

WE OPERATE SEVERAL diesel engines that have brass oil pipes going through their water jackets. These pipes thread into the cylinder liners and supply oil to the pistons. Because of expansion stresses the pipes often broke at the liner threads. Water got into the crankcase and we had to stop the engines to take water out of the oil.

To CURE this trouble we rebuilt the pipes as in the drawing. We drilled each ¼-in. brass pipe to 7/32 in. inside diameter. Copper tubing of the same length with 3/16-in. outside diameter was put in each pipe. Silver solder at each end held the tube in place.

We shaved each pipe near where it usually broke to let it bend without breaking. Annular clearance between the two pipes let them bend easily. If a pipe does break, the soldered connections between it and the tubing won't let water get into the oil.

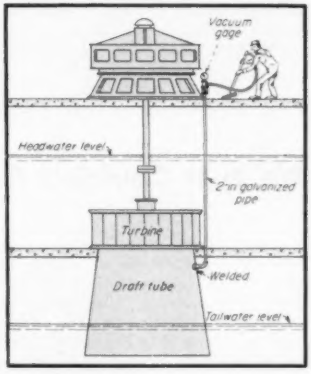
The copper tube is flexible enough so that it does not strain the soldered joints, because of expansion and contraction. This change in the pipe did not need any changes in engine parts.

H GREINER *Anoka, Minn.*

Hydro-Turbine Draft-Tube Vacuum Cleans Plant

I RUN A SMALL hydroelectric plant which has francis turbines with draft tubes. We could not get the money to install a vacuum cleaning system to help clean the plant.

When we put in a new unit, in the



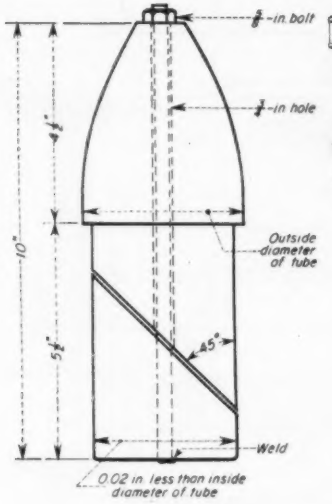
side of its draft tube we connected a 2-in. pipe with valve and ran it to the operating floor. To the pipe we connected a vacuum cleaning hose with a nozzle on its end. When the unit was running we had a cleaner with more than enough suction to pick up all dirt.

E A ROBERTS *Carlsbad, N.M.*

Tool Guides Boiler Tubes Through Baffles

WHEN PUTTING new tubes in a boiler we had trouble guiding them through displaced baffles. We solved this problem by the tool shown in the drawing. It is made from a solid piece of round steel about 10 in. long and of a diameter equal to that of the tube's outside.

For 5½ in. of its length the rod is turned to 0.02-in. less than the inside diameter of the tube. The other half is



nosed down to 1½-in. diameter, so it easily enters the baffle holes. The rod is bored through for a ⅝-in. bolt and then the 5½-in. section cut in half at a 45-deg angle. The hole in the nosed section is enlarged to ¾ in. for clearance around the bolt in the base.

When the tool is put in the tube and tightened with the nut on the bolt, the two halves slip on the 45-deg joint and lock in the tube. The tube can then be pushed through the baffles with the tool guiding the way. When the tube has been pushed through, loosening the nut releases the tool and it can be taken out to use in the next tube.

E L FAUTH *Quarryville, Pa.*

Valve Not Closed Runs Pump Backward

WE have a motor-driven centrifugal brine pump, that circulates brine at 45 psi. It is used as a spare for a triplex plunger unit. The centrifugal is also used over weekends to permit us to inspect the main pump.

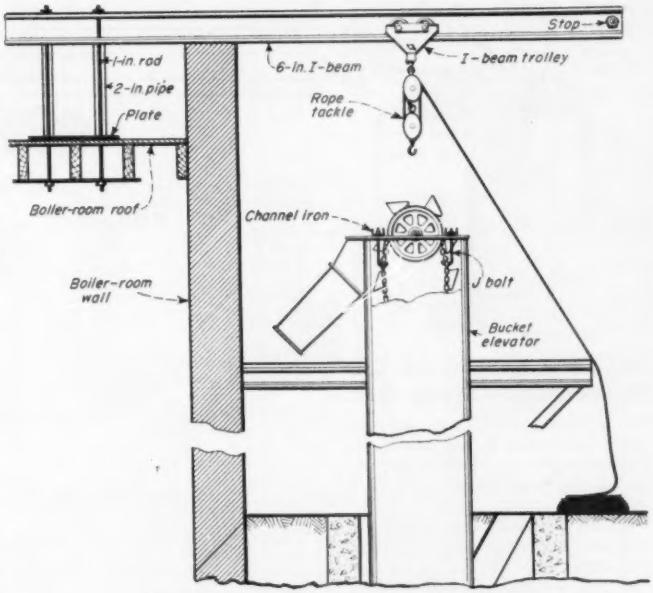
Often a fuse would blow in the motor starter when starting the centrifugal. This happened to me the first time that I tried to start it. As the circuit was fused as heavy as it safely should be I looked around for the cause of the trouble instead of accepting the necessary evil.

I found that there was no valve in the pump's suction line and the discharge was out near the main line. This valve had an extension stem running up to the operating floor so it could be opened and closed from there.

I looked at the pump and it was revolving backward; the discharge valve had not been closed. Brine was flowing from the main back to the tank through the pump to drive it as a motor. The discharge valve was then closed and the pump started without any trouble. The motor running backward when started caused a heavy inrush current that blew the fuse. We then installed a check valve in the discharge at pump, which cured the trouble.

J R WILLIAMS *Columbus, O.*

More PRACTCAL IDEAS on page 132



MAKES QUICK GEAR CHANGE

WE HAVE a bucket elevator outside our power house for handling ashes from the ash pits of stoker-fired boilers. The top sprocket of this elevator was badly worn and had to be replaced. This offered a problem of how to get the old sprocket down and the new one up to the top of the elevator.

First, we had to have a hoist. This we made from a 6-in. I-beam cantilevered out over the boiler-house wall parapet as in the figure The inner end of this beam we tied down to the boiler-house roof with 1-in bolts through 2-in. pipe as shown.

This beam, on which we put an I-beam trolley, extended out over the sprocket and driving gear. The trolley could be run over the gear for lifting with a tackle.

With the tackle we lifted the hood off the elevator and lowered it to the ground. Next, we placed two pieces of 4-in. channel iron across the top of the elevator casing. We removed some of the top buckets and with two J-bolts took the weight of the elevator on the channel irons and got the needed slack. This let us take the elevator chain off the sprocket.

After removing bearing caps the old sprocket and gear was lifted out and replaced with a new one. The elevator was then assembled and put back into service with little trouble.

The I-beam and tackle also come in handy if the elevator chain breaks and the buckets drop into the casing. Lifting the chain and buckets with the tackle is about the only way to get them back in place.

G G AVANT *Wilmington, N. C.*

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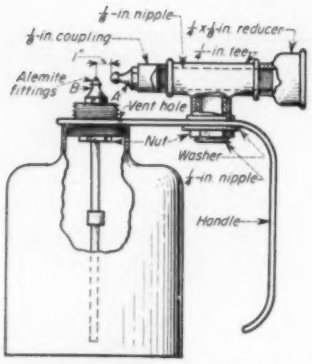


Old Long Necked Oil Can Makes Handy Spray Gun

THE DRAWING shows a handy spray gun that I made from an old long-necked one-quart oil can. It does a better painting job than a brush and in about half the time.

Remove the spout and trigger from the can. Keep only the handle and the inside tube. The materials, their size and assembly are indicated on the drawing. The alemite fittings have their ball check valves removed.

The spray nozzle connects to the plant's compressed-air supply. Put a ¼-in. valve in the air line to regulate the pressure to the nozzle, mounted on the can's handle as shown. Air blowing from nozzle *A* across *B* acts as an aspirator to draw paint from the can and spray it on the surface being painted.

FRANK FEDOROCSKO *Bayonne, N. J.*

Settling Tank Clears Well Water of Sand

WATER from wells gave trouble when the water level dropped in the wells. Sand and air got into pumps and heat exchangers. Cavitation caused by air in the water and sand deposits increase maintenance cost and outage of pumps and exchangers.

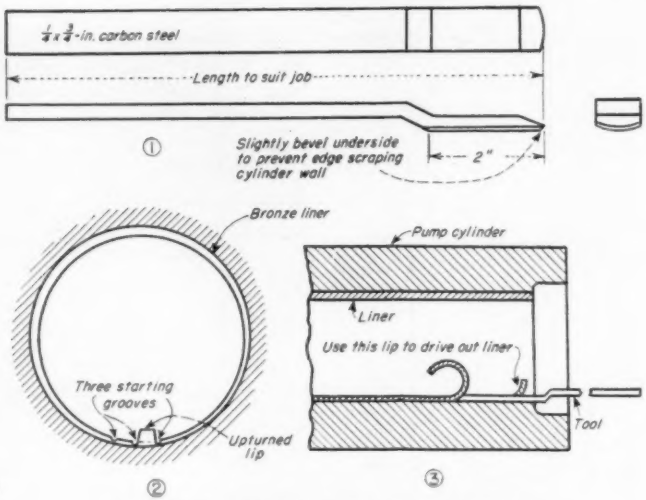
To solve this problem we installed a large tank in the discharge line from the wells as in the drawing. The drop in water velocity through the tank lets air bubbles rise to the top and sand settle to the bottom of the tank.

The tank is 15 ft long and 5 ft in diameter. For 1000 gpm flow, water velocity drops to 0.11 fps in the tank. Weekly venting of the tank is enough to remove the air. Once every two months we take the tank out of service and shovel out the sand.

Opening the blowoff valve takes out some sand, but not enough to clean the tank. Water outflow line must be connected high enough so that water will not pick up sand that has settled out. A bypass is needed so that the tank can be taken out of service for cleaning without stopping water flow from the wells.

J D CONSTANCE *Cliffside Pk, N.J.*

More PRACTICAL IDEAS on page 134



TOOL REMOVES CYLINDER LINER

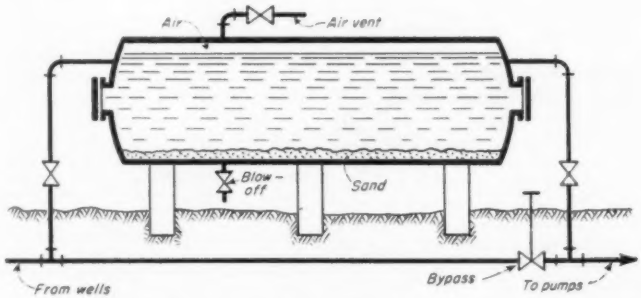
TO TAKE bronze liners from reciprocating-pump water cylinders may not be easy. Often there is little space to work, and care must be taken not to injure the cylinder bore. Our tool, Fig. -1, does the job quickly and will not harm the cylinder.

Before using the tool, with a grooving chisel cut three grooves ½ in. long nearly through the bottom side of the liner, Fig 2. Cut these grooves slightly farther apart than the width of the tool used to cut them with.

With the tool curl up the end of the liner between two of the grooves for about an inch. Oil the tool and drive it under the section between the upper two grooves and all the way through the liner, Fig 3

When the liner has been parted put a rod through the piston-rod hole against the upturned lip and drive out the liner. Using this method I can take out the liners from a duplex hot-water pump in less than one hour.

W H THOMAS *Rodney, Ont.*



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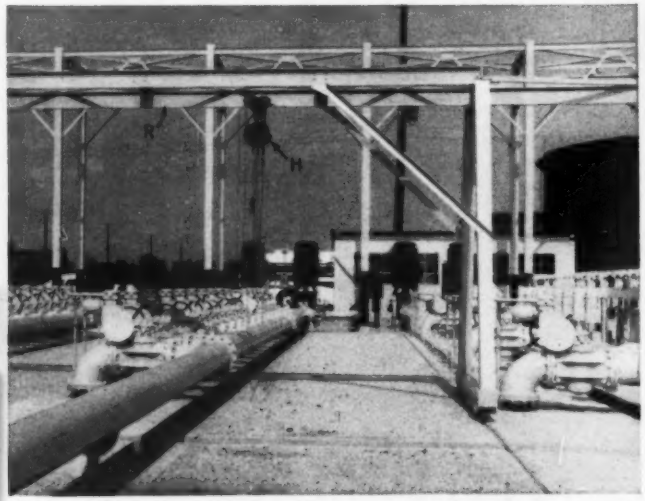
More PRACTICAL IDEAS

Begins on page 130



HOIST DOES HARD VALVE WORK

ON ONE LARGE PIPE LINE hard work is cut by a traveling gantry crane on rails, which spans the valves, as in the photo. A chain hoist *H* on a cross rail *R* of the crane allows any valve to be lifted from place without disturbing the others. The free valve can be taken quickly to where it may be loaded on a truck for transfer to the repair shop.

With the gantry, valve changes can be made using only two men, one of whom may be the driver of the service truck. Strain may be taken with the crane and hoist from valve flanges when loosening them or when putting in a blankoff plate. When installing a valve the hoist supports the valve in good alignment before bolts are tightened for leakproof operation.

ELTON STERRETT *Houston, Tex.*

Set Flexible Coupling Tight on Shaft

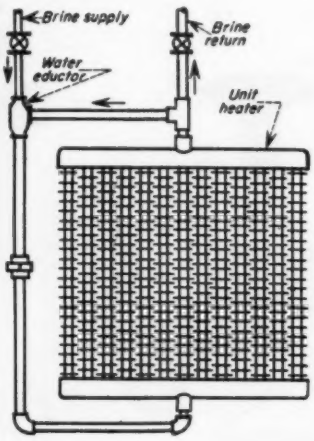
A FLEXIBLE COUPLING on a centrifugal boiler-feed pump separated twice and shut down our oil-fired boiler on the low-water cutout. We then checked the coupling each afternoon before going off duty to make sure that the setscrew was tight. In time, repeated tightening of the setscrew stripped the thread in the motor half of the coupling. This left no way to hold the two halves of the coupling and their leather separator together.

With the coupling hub in its normal position, we prick punched the shaft at the inside end of the hub. We then set the motor back, took off the coupling half and drilled and tapped the shaft for a 3/16-in. bolt. We screwed the bolt in and cut it off so that about ⅛ in. extended beyond the shaft. The bolt ends were then peened to prevent its moving. This bolt served to keep the coupling going in too far on the shaft.

After putting the coupling on the shaft we turned a size larger capscrew into the stripped setscrew hole. We had some doubts if this could be done, but after trying we found the metal soft enough in the hub to let the screw cut its own thread. When the screw was set hard on the shaft we cut it off about ⅛ in. from the hub and slotted its end with a hacksaw.

The leather separator between the coupling halves was badly worn, so we made a new one from a piece of flat leather belt. The pump, when put in service, ran smoothly and the coupling has remained tight.

A H PARKER *Peterborough, N. H.*



Unit Heaters Air-Condition Offices

WE CONNECTED unit heaters to the refrigerating-brine piping to cool small offices. This is an easy way of doing the job at low installation cost. The brine supply is usually below 20 F, which causes the heater-finned pipes to frost heavily.

This frost gradually covered the pipes and it was necessary to defrost every 2 or 3 hr so that air could circulate around them. To do this the brine had to be shut off, causing a loss in cooling effect. We cured this trouble by installing a water eductor as in the drawing.

Enough of the warm brine leaving the unit is recirculated to raise the brine's temperature above freezing. The finned surfaces now operate without frost to give efficient cooling.

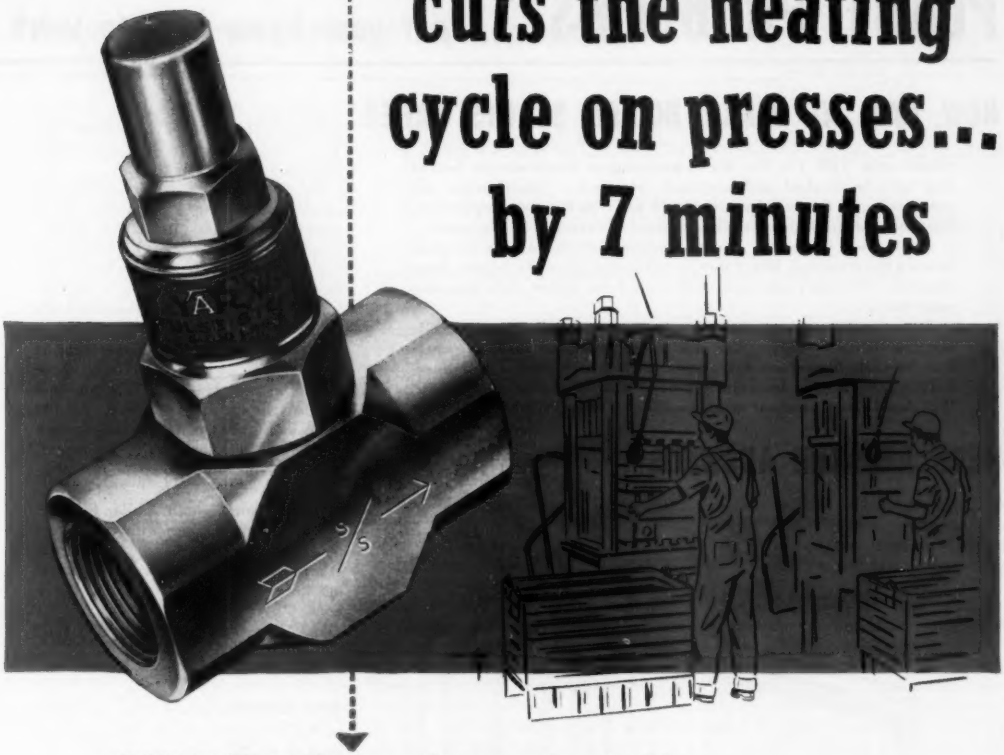
ROY EMISON *Kansas City, Kans.*

Scotch Tape Shows Water Level in Gage Glass

MANY DEVICES have been used to make the water level more easily seen in gage glasses. Some of these use lights and other color schemes placed back of the glass. Gage glasses are made that have a red stripe running their full length. The glass is installed with the stripe in the back so that it colors the water and makes it more easily seen in the glass. I use a ¼-in. wide strip of scotch tape on the back of our gage glasses. This helps a lot to make the water level more easily seen at a distance.

E L FAUTH *Quarryville, Pa.*

cuts the heating cycle on presses... by 7 minutes



PROBLEM: What to do when production requirements call for a speed-up in the heating cycle.

SOLUTION: (A typical one supplied by a western molded-rubber plant) Equip presses with Yarway Impulse Steam Traps.

RESULT: Heating cycle now 8 minutes instead of their usual 15, a saving of nearly 50%.

Yarway Impulse Steam Traps are designed **to get equipment hotter, sooner, and keep it hot**—thereby increasing production. In operation, Yarways send the most premium B.T.U.'s at top temperatures into your product or process.

Other reasons why over 750,000 Yarways have already been installed are—one moving part, low maintenance, small size, easy installation, good for all pressures, made of stainless steel, low cost.

It's easy to buy Yarway Impulse Steam Traps. One of 216 industrial distributors who stock and sell them is located near you.

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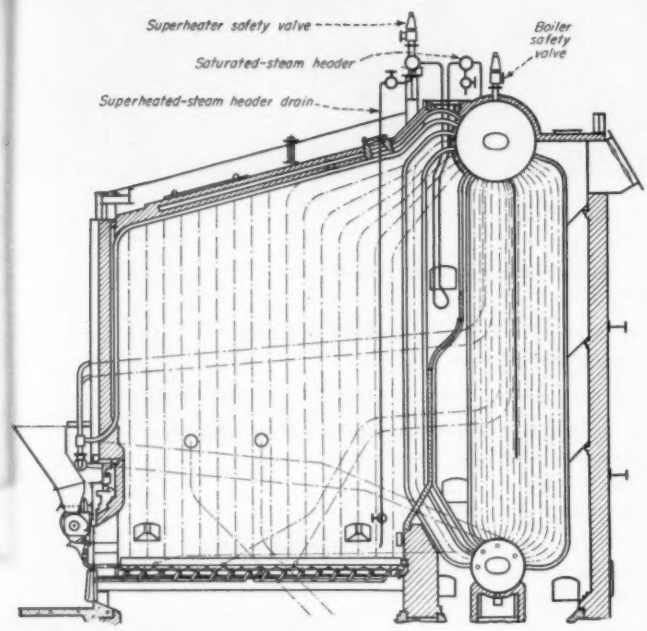
HOW CAN WE MAKE BOILER STARTS SAFE?

HERE ARE THE FACTS: We're planning to install several boilers that will be banked and restarted frequently. Superheaters are pendant type. Steam pressure is 400 psi, 700-F total temperature. Spreader stokers in completely watercooled furnaces will be used.

Units could be started rapidly if there were no danger of overheating superheaters. But if they aren't cooled properly we may burn them out. We can't take saturated steam from boiler while warming superheater.

Steam at 250-psi saturated is available from another source while starting the new boilers. Can this steam be passed through superheaters while boilers are being restarted? Will it protect the superheaters? What pipe hookups are best? Are special valves needed? Will rapid starts overheat drum steel?—ER, Apr POWER.

HERE ARE THE ANSWERS



HERE'S our standard procedure for banking and restarting a boiler and pendant-type convection superheater. We've used it safely for many years.

Starting up—drain saturated-steam header; close drain valve. Keep superheated-steam header drain valve open until boiler is cut in on line, then close it. This allows steam flow through superheater as soon as the water boils and before gases become hot enough to damage these vital elements.

Banking — open superheated-steam header drain valve so enough steam flows through elements to protect them until gas temperature falls to a safe value. With spreader stokers in waterwall furnaces, temperature drop is quite rapid.

No other means for cooling convection superheaters is needed. Circulate steam or water through radiant-superheater elements until boiler starts steaming. Provide free blow to atmosphere for superheater drain lines; this must be independent of boiler blowdown line. Don't allow drains to discharge where they may injure operators.

Safety valve on superheated-steam header is set 3 to 5 psi below lowest setting of a boiler safety. This assures ample steam flow through elements if load drops suddenly. Reduce firing rate immediately after load drop to prevent prolonged blowing of superheated-steam header valve.

Increase boiler-water temperature at a rate of about 100 F per hour above feedwater temperature. This prevents undue stresses in boiler steel. At 400 psi, which corresponds to a temperature of about 450 F, and 200 F feedwater, boiler can be brought up to full pressure in about 2½ hours.

Sketch shows a unit similar to *ER*'s. Fit header drain lines with two valves as shown. One is close to header, the other handy to operator. In normal operation upper valve is closed, lower open.

H G MEISSNER *New York, N.Y.*
Combustion Engineering-Superheater, Inc

TWO FACTORS govern rate at which watertube boilers can be brought from banked to full-steam conditions: (1) thermal stresses in boiler drum must be within acceptable limits, (2) superheater must be protected from overheating.

Thermal stress won't be excessive if temperature differences in various parts of drum don't exceed 100 F. Boiler drums in the 400-psi-design pressure range are relatively thin. Superheater sets your firing limits. Actually, if boiler pressure were 120 psi (350-F sat. temp) at the end of the bank period, pressure could be raised to 400 psig (448-F sat. temp) instantaneously without going over the 100-F limit. Check temperature differentials by peening thermocouples to top and bottom of drum at several points along its length.

During out-of-service periods steam condenses in superheater and fills loops with water. This must be boiled out before unit delivers much steam. When partially filled with water no steam can flow through superheater to cool dry sections of tubes and they may reach a temperature close to that of gas flowing over them.

Fit bare thermocouples to carbon-steel sections of superheater so temperature can be checked. Locate at point of maximum gas temperature in super-

help the other guy cure his headaches

TYLER HICKS, *Assistant Editor*

heater inlet. Use as guide to firing rate that limits gas temperature entering superheater to 900 F. Don't exceed this temperature limit until after all superheater tubes have been boiled out and unit delivers steam.

Thermocouples peened to key superheater tubes out of gas stream read close to saturation temperature as long as there is water in tube. There's a sudden temperature jump when tube clears.

With short banks of several hours, or less, "bottle up" boiler as soon as all fuel in furnace is consumed. Do this by shutting all boiler steam outlets and air inlets so unit cools as slowly as possible. Boiler pressure stays up and there's minimum condensation in superheater.

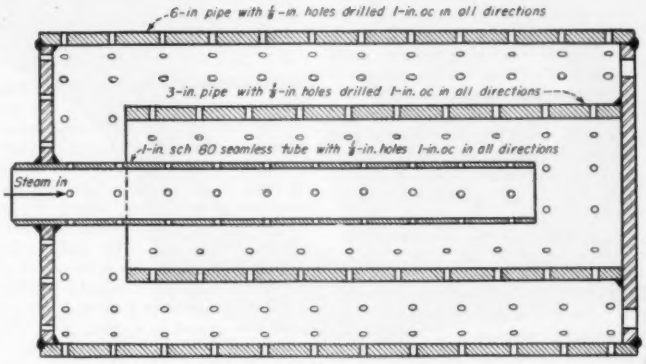
High cost of pipe, valves and other equipment makes impractical any use of an outside steam source for purging superheater. But if steam purging is desired, run a line to atmosphere, fitting it with a shutoff valve suitable for 700 F. Connect to bottom of steam line near superheater, using boiler pressure to blow water out of superheater. Drains on superheaters don't permit enough steam flow to purge them because 25% or more of full-load steam flow is needed. Have drains open during start but don't blow slugs of water into hot steam lines where they may break open flanged joints or damage other units.

HUSTACE H POOR *New York, N.Y. Babcock & Wilcox Co*

LEAVE DRAIN VALVES on superheater closed when boilers are taken out of service and you won't have to worry. Steam in superheater tubes condenses as furnace cools and they fill with condensate. When starting, superheater drains must be opened to release condensate and steam. If boiler has been idle for some time and lower coils are cold, open drains slowly so there isn't any chance of waterhammer. Use a slow fire for a few minutes with drains closed. This raises condensate temperature, prevents trouble. Open drains slowly until drain-pipe and coil temperatures are constant. Listen for cracking sounds in system. If there aren't any, open valves wide to drain the superheater completely.

If only one drain valve is fitted, install another on opposite side of superheater header to hasten drainage and warm-up. There's no need for elaborate piping systems and valves on this job.

VINCENT STROJSA *Glace Bay, N.S.*

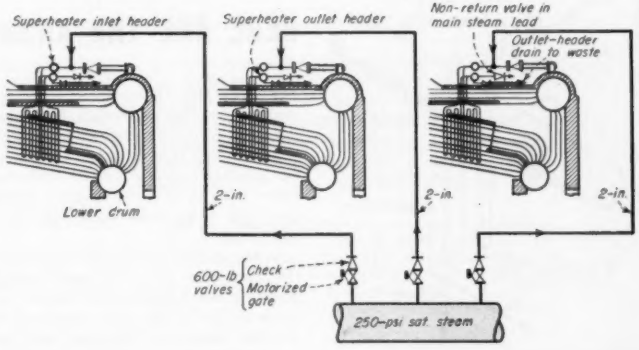

6-in pipe with ½-in. holes drilled 1-in. oc in all directions
3-in. pipe with ½-in holes drilled 1-in. oc in all directions
1-in. sch 80 seamless tube with ½-in. holes 1-in. oc in all directions
Steam in

QUICK STARTS are easily made if superheater drains to atmosphere are left wide open whenever boiler is not on line. There's no need to pipe 250-psi steam to superheater for cooling if drains are left open. We've used this method for more than a year on both fast and slow starts of a traveling-grate spreader unit at 600 psig and 725-F total temperature. Pendant-type superheaters haven't warped or distorted.

Main trouble we've had with method came from complaints of nearby residents who said venting of high-pressure steam was noisy. We solved this by building muffler in sketch above. It reduced noise level so well we built three more and put them on 450-psig units where we use same superheater protection.

Refractory piers on front wall between stoker feeders limit rapidity of starting. From a cold start we like to take 2½ to 3 hours to put unit on line. Anything under 2 hours jumps pier refractory maintenance. For quick-start jobs, cool piers with air or water. Better yet, install feeders so piers aren't needed.

J L AIKMAN *Drummondville, Que.*



SKETCH shows three boilers hooked up for superheater protection during starts. I've assumed there are one or two leads between steam drum and superheater inlet header. Install 600-lb check valves in one or both leads to prevent heating steam from flowing to drum and condensing during starts. Use a 2-in. Schedule-80 pipe between lead and 250-psi steam header. Connect beyond check valve, as shown. Fit gate and check valve to heating steam line; motorize gate valve for centralized control.

Inject heating steam about fifteen minutes after boiler start; this prevents excessive stresses. Lock boiler nonreturn valve closed during superheater

Begins on page 136

heating. Open superheater outlet drain valve so steam passes to blowdown tank. Setup in sketch reduces start-up time from 1½ hours to 45 minutes or 1 hour.

Shut off heating steam and open nonreturn valve when drum pressure is 225 psi (392 F). Close superheater drains as you would in normal start-up.

If there are many tubes instead of one or two leads between drum and inlet header, heating steam can't be used. Increase superheater temperature with flue gases, using thermocouples to check.

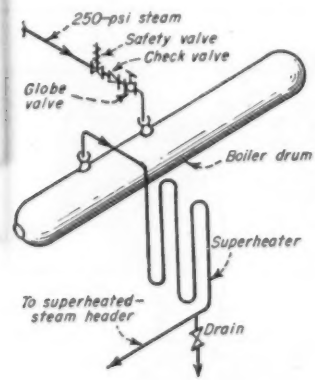
A J Breugelmans *Hoboken, N.J.*

INSURANCE or state inspectors probably would not allow any piping hookup where 250-psi steam enters the superheater section of a 400-psi unit. If such a scheme were permitted I doubt if the boiler manufacturer would approve it. It would interfere with normal water and steam circulation, doing more harm than any overheating of superheater tubes.

Under normal conditions all *ER* need do is keep superheater outlet-header drain valves open until right temperature and pressure have been reached to maintain flow through tubes to prevent overheating.

With 1¼-in. drum plates rapid starting won't overstress them. *ER*'s best bet is to call in an engineer from a boiler manufacturer and get his advice.

D D Smith *Akron, Ohio*



BOILERS fitted with bypass dampers that prevent hot gases from reaching superheater during start are best solution to problem. These eliminate many pipe and valve difficulties.

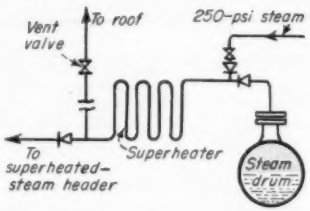
If *ER* decides to use 250-psi steam, he can connect to boiler drum as in sketch above. When boiler is needed, turn on 250-psi steam, crack superheater drain, build up fire, open drain wide and force fire to maximum. As soon as boiler hits 250 psi, check valve shuts off outside steam.

Albert R Eckert *Mt Vernon, Ill.*

SPOT THERMOCOUPLES on superheater tubes, drums and boiler tubes. Try different start-up periods with superheater vented to atmosphere. Knowing maximum allowable temperatures for metals in unit, a definite firing-time relationship can be established. Piping 250-psi steam to superheaters requires a nonreturn valve, stop valve and piping for 400 psi, 700 F. It's practical. Test procedure outlined is valuable in finding how much cooling steam is needed and time gained by its use.

Melvin Evans *Chicago, Ill.*

Editor's Note: *Some readers overlooked the fact that* ER *plans to use a pendant superheater; ordinarily these are nondrainable. However their answers were included so* ER *will know how to work with other types, too.*



FORGET GADGETS and apply some sound design. Don't "slam" boilers on and off the line. With a little thought and planning, cutting in or out can be anticipated, adequate time allowed and boiler brought up to right temperature as manufacturer recommends. Use mechanical equipment correctly and schedule production *vs* steam generation.

ER can use saturated steam, if he cares to. Piping as in sketch above does trick. But at all costs, be careful how you hook up piping. Severe burns can result from carelessness.

A M Palmer *Brooklyn, N.Y.*

SHOULD WE UNDERCUT OUR COMMUTATORS?

HERE ARE THE FACTS: In turning down commutators on single-phase motors of different types, when should they be undercut? Also, what grade carbon brushes should replace them? Would like to hear from readers who have done a lot of this—JHG, Jan, OE.

HERE ARE THE ANSWERS

YES AND NO. In general, undercut commutators that were originally undercut, after truing them up, or when high mica develops. Commutators not undercut originally should not be undercut after truing up, but use a harder brush that will wear down mica uniformly with copper.

In the case of direct-current exciters the commutator often becomes roughed up and grooved and flecks of copper are thrown off. In this case, changing to a softer brush will overcome problem permanently.

There are two theories on cause of this condition. One is that where copper flecks are found, it's caused by an electrolytic condition.

The other theory is that the manufacturer furnishes brushes designed to full-load operation. And in the case of exciters, the brushes are often too hard for the light loads encountered. So hard carbon dust that would be ordinarily burned up under full-load conditions, accumulates under the brushes and causes grooving.

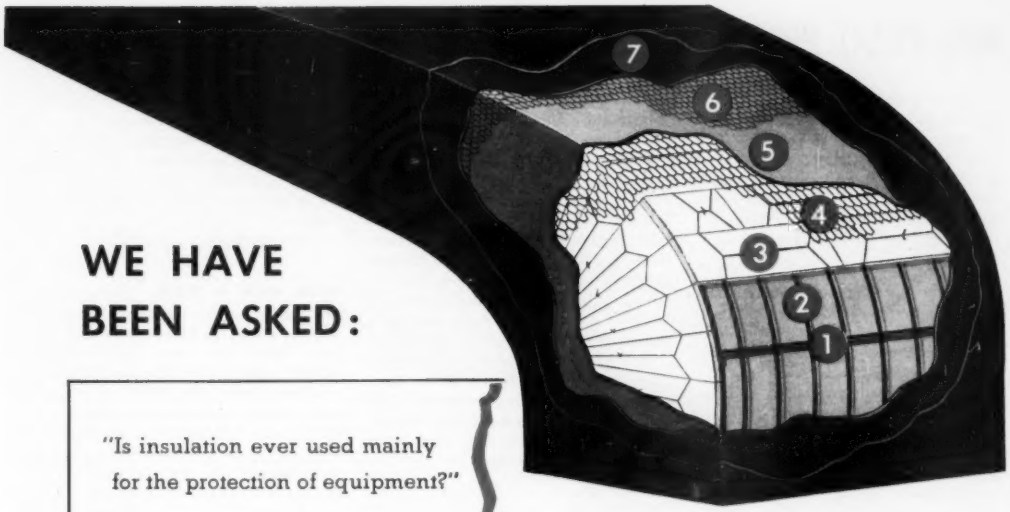
Removing one brush from each set and throwing more load on other brushes often corrects this condition. But I prefer using a softer brush.

A M Damerow *Elk River, Minn.*

SEVERAL TIPS. Consult a good electrical handbook—it has all the answers you need.

In a single phase repulsion-induction motor, the mica should be about level with the commutator bars. When undercut too deep and the load is applied to motor, it sparks. This in turn pits and burns the commutator. Under proper operating conditions, commutator should take on a chocolate color. Have carbon brush exert about 1½ psi.

In general, with a slotted commutator,



WE HAVE BEEN ASKED:

"Is insulation ever used mainly for the protection of equipment?"

"I've always thought of insulation as a means of conserving heat or refrigeration," writes a student engineer. "Is it worth the expenditure to use insulation mainly as protection for equipment?"

We answered the question by writing that we have come across quite a few cases where the main purpose of insulation was not to save heat or cold, but to save the equipment itself. For example, at many modern steam generating plants you'll find insulation on the outdoor metal breechings carrying waste gases to the stacks. While the insulation improves draft and efficiency, its main purpose here is to eliminate internal corrosion.

Although the gases are usually at high temperatures, some of the corrosive combustion products will reach their dew points when the gases contact the cooler metal surfaces of an uninsulated breeching. Condensation occurs, and a corrosive liquid is deposited on the interior surfaces. To minimize this condensation, insulation is applied to keep the breeching at a temperature above the corrosive components' dew points.

Because no completely satisfactory coating has been found to protect the outer surfaces of the metal, the insulation, when it is thoroughly weatherproofed, also protects the outside of the breeching against rust, fumes, and other causes of deterioration.

1. Transverse stiffeners on breechings;
2. ¼" pencil rods welded on;
3. 1" thick 85% Magnesia wired in place;
4. 2" mesh hexagonal wire netting wired to blocks;
5. Asbestos cement ½" thick (2 coats);
6. 1" mesh hexagonal wire netting;
7. Armstrong's Insulmastic (2 coats).

Method of insulating breeching used by large generating station. Main purpose: protection of metal.

Advising when insulation should be used, as well as how it should be put up, is part of the service offered by Armstrong. Armstrong maintains a contracting organization to provide a complete insulation service—including top-quality materials and trained men to apply them.

SEND US YOUR QUESTIONS: If you have any questions on the use or application of either high- or low-temperature insulation, please do not hesitate to write to us. We'll do our best to give you a practical answer. Just address a letter or post card to Armstrong Cork Co., 7007 Maple St., Lancaster, Penna.

ARMSTRONG'S INDUSTRIAL INSULATIONS
MATERIALS - INSTALLATION
FOR ALL TEMPERATURES FROM 300°F. BELOW ZERO TO 2800°F.

More PLANT PROBLEMS

Begins on page 136

use a soft brush. Reason is there's not the same tendency to wear away brush as with an unslotted commutator. Then commutator should take on the desired polish that's generally not obtainable with a hard brush. Life of both brush and commutator will be increased.

B D RILEY *Brunswick, Ga.*

SINGLE PHASE. Slightly undercut single-phase commutators to insure no high mica, which if present, would result in serious sparking and burning of commutator. Use a medium-grade carbon brush with enough abrasive quality to keep the commutator clean.

The additional expense in undercutting will be repaid by less trouble due to burning, arcing and pitting of commutator.

Undercutting should not be deep, which would permit an accumulation of dirt and carbon.

C L SPRAY *Bayside, N.Y.*

DEPENDS. We have several hundred types of fractional-hp motors, mostly AC commutators, (that is repulsion-start induction-run type motors). The brush riding or brush lifting designs are *not* undercut. However, depending upon service and condition, commutators on universal and repulsion-type motors are sometimes undercut.

As to the grade of carbon brushes to be used, it's always best to replace carbon brushes with the type specified by the manufacturer. I've found that any economy derived with substitute carbon brushes will be greatly offset by greater maintenance and upkeep expenses.

C BACHMANN *Forest Hills, N.Y.*

WHEN TO TURN. Undercut commutators whenever mica between the segments of commutators becomes higher than or is level with segments. This results from turning down commutators or from wear.

As to the grade of carbon brushes, usual procedure is to replace with same type as original old ones.

A J WENIG *Brooklyn, N.Y.*

EDITOR'S ADVICE. Commutator slotting or undercutting is accepted for ac as well as dc motors. It is common practice to cut the mica away about 1/32 in. below commutator's working surface. You can do this with a small high-speed XX saw designed specially for this job or an old hacksaw blade.

Commutators are undercut to prevent the mica insulation between commutator segments from jutting out above the commutator. In most cases the copper commutator segments wear faster than the mica.

I won't make any specific recommendations about grade of brush to use. It's not that easy to change from the type recommended by the motor manufacturer. Many operating men jump to changing brush grade soon as brushes spark. Primary cause of trouble may be other than brushes; load conditions, operating practice, neutral position, etc.

Best bet when thinking of changing brush grade is to call in a brush manufacturer's local representative. He makes electrical brushes his life's work. And he can steer you clear of common pitfalls—JIM O'CONNOR.

ALL UNDERCUT HERE. All commutators in our plants are undercut. Undercutting thoroughly cleans out all particles of copper from the mica and leaves the bars' edges smooth. Be sure to chamfer the bars' corners to reduce scraping action on brushes.

Several reliable brush companies supply us with satisfactory brushes after we give them data on our equipment. We have been buying our brushes for several years from one concern, for various makes of equipment.

Brushes can also be bought from the equipment manufacturers. But where several different makes are used it means purchasing from several different concerns.

G W BENEDICT *Montpelier, Vt.*

WHEN MICA IS HIGH. Commutators need undercutting when the mica insulators are level or above the copper bars. They may need undercutting without turning down the commutators.

Carbon brushes should be soft enough not to wear the commutator badly, yet not so soft that they wear excessively. Best way is to call in a carbon-brush manufacturer. He will be glad to tell you the best type of brush to use.

C A FREY *Chicago, Ill.*

LESS MAINTENANCE. On small single-phase motors the mica is usually left flush. Mica wears slower than the copper but the right brush will give satisfactory results.

A slight undercut gives more service so commutator doesn't have to be turned down so often.

C R DAY *Mount Dennis, Ont.*

YOUR NEW PROBLEMS

1—How Can We Set Up a Work Schedule?

WORKING HOURS, holiday and vacation schedules are now being changed in our plant rather frequently for a number of reasons we can't control. Changes upset shift schedules; we must restudy crew for every change. At times we have too many men on hand; at others, too few. Condition isn't healthy and we'd like to clear it up.

We're looking for a schedule that takes care of all shift operators' work without too much "figurin'." We operate 24 hours a day, 7 days a week. Our boilers and turbines are hooked up on the unit system.

Is there any formula or chart we can use to figure work schedules? We're not looking for a schedule that fits a specific set of conditions; instead we want a formula or method of manipulating the various factors so we can get the best results with least trouble.—WB

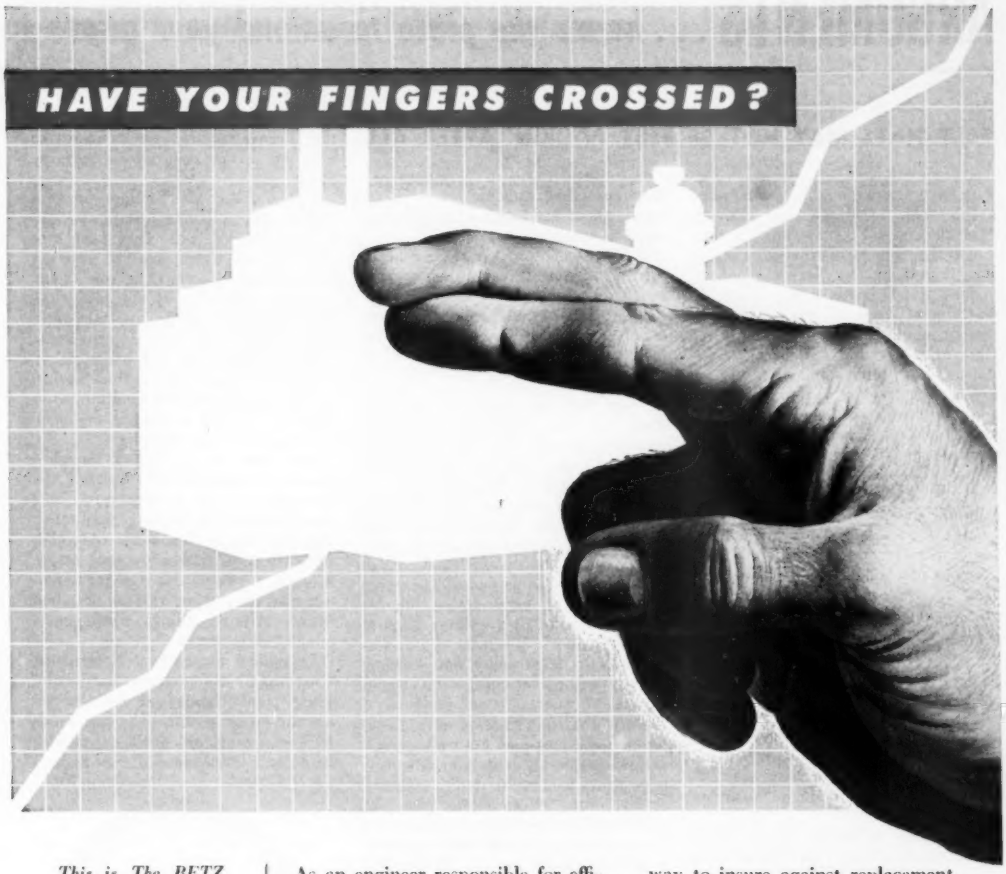
2—How Can We Meter Condensate Returns?

I'M IN CHARGE of a process-steam plant in which almost 100% of the condensate is returned to the boiler room. It comes from vats, drying rolls, air-conditioning units, the steam heating system in one of our buildings and several other sources. We meter steam flow out of boiler room but have trouble getting accurate readings on condensate. Meters we've tried have registered steam or been damaged by high-temperature steam.

Now what I'd like to know is this: how can rotary or tilting condensate meters be piped to protect them from damage and incorrect readings? What about volumetric meters? How should we connect meters to pressure, gravity and vacuum return lines? We need hookup sketches.—JA

Help these readers? Published answers are paid for; extra for photos, sketches.

HAVE YOUR FINGERS CROSSED?



This is The BETZ INDICATOR, a monthly publication devoted to general discussion of all water problems. It's free. Write.

As an engineer responsible for efficient plant operation, you know all-too-well that any number of things can go wrong, *at any time*, to stall important plant production. Take industrial water problems, for instance.

If scale, foaming, corrosion, algae, embrittlement, or a host of other boiler and cooling water troubles cause you concern, why not take a direct route to uninterrupted production through the use of an adequate and well-balanced program of water conditioning? It's a sure way to insure against replacement of hard-to-get plant equipment, too.

If you want *results*, then BETZ can be of assistance to you. Here in one organization you will find the facilities and services necessary for the efficient solution and control of all water problems. May we have a BETZ engineer call? He'll show you how you can get 'round-the-clock' results in your plant—fast!

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada, BETZ Laboratories Limited, Montreal 1.

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

ARGUMENTS... *here's the place to unload your gripes to*

FELT HATS MAY NOT BE BEST PACKIN' AFTER ALL

THE FIRST SENTENCE in the second paragraph of Mr Yarbrow's letter (POWER, May 1951, p 151) shows that at least *one* of the "important" things he should have been taught in college was omitted.

John Hyler, in his article which Mr Yarbrow referred to, was speaking of modern operating practice and not the days of tallow and flax packing, felt hats, potato peelings and beer cans.

Contrary to Mr Yarbrow's college training in "details" and "important" things—the fact remains that packing in modern high-speed pumps and compressors must be, and is, engineered to the exact service for which it is used.

Water pumps are the easiest of all pumps to pack but in this day and age we have more at stake than the mere stopping of a stuffing box leak. We must look to conservation of shafts and sleeves which cost a lot of money. On one pump in our plant we pay $175 for each sleeve and $600 for a new shaft. It is obvious that proper packing becomes a very "important" item.

All major packing manufacturers today strive constantly, through research and tests to produce the finest packing from the standpoint of long life, efficient sealing and minimum wear on moving parts.

It is tough to answer in one letter all of the questions raised by a questioner that didn't, or couldn't, learn much in four years of college. However, I suggest Mr Yarbrow get his hands on the latest catalogs of Garlock, Crane, Durametallic Corp and other packing manufacturers. Read them, study them—and your idea of "details" will come of age.

I dislike to see a young man just out of college, and on what is perhaps his first industrial assignment, sounding off on a subject he admits he never studied.

I dislike even further to see letters such as his in print. I believe it would be better for all concerned if, upon receiving such a letter, the editor would return it to the sender with the courteous explanation that "Arguments" is not a clearing house for educational tirades or college deficiences.

I hesitate to predict how long, if ever, it will take Mr Yarbrow to earn for his company, the money it invested to create his job before he even went to work for it.

Today, as never before, the young man who is just embarking on his life's career and who fails to learn all of the facts concerned with his job, need not worry about his future. He will have none to worry about.

B D TITUS *El Dorado, Kans.*

EDITOR'S NOTE: POWER'S *editors felt that Mr Yarbrow's letter should be published. Then he, and others like him, could see how experienced men like Mr Titus felt about packing.*

A LONG TIME BACK, when I was handling oil cans, punching tubes and polishing brass in the engine room of a Great Lakes freighter I helped fit out the old *La Salle* in Erie, Pa.

The Second Engineer, like Mr Yarbrow, was very broadminded about packing and claimed that an old piece of heaving line was plenty good enough packing for the bilge pump. The pump was a vertical, single-acting plunger pump, connected by a walking beam to the main engine. When the engine was running, the bilge pump was working. If the engine stopped, the pump stopped.

We had to run to Lorain to load coal for an upper-lake port and we were outside the harbor about an hour, when the bilge pump packing started to leak and at every turn of the engine pieces of manila line and gallons of water would shoot up through the main-floor grating with the force of a fire-hose stream. We didn't dare stop the main engine—unless the engineer wanted to spend the rest of the summer trying to explain what had happened.

We laid planking on the grating to keep the water in the lower engine room. Then we pumped the bilge out with the steam syphon and made port on time. But I had to clean up the dynamo and switchboard and bilgewater. And (you can ask Marmaduke about this) that just ain't nice work.

Years later I took charge of a plant in a large hotel where they had just packed an ammonia rod "with anything they could get their hands on." I had to call the Fire Department in on that packing job.

If Mr Yarbrow keeps on packing them with felt hats, he'll find out for himself what I couldn't tell him half so well.

J E GLEASON *Plymouth, Mich.*

MR YARBROW is getting a load of righteous indignation off his chest. Naturally he is het-up over the easy operator's license requirements as compared with his higher educational requirements.

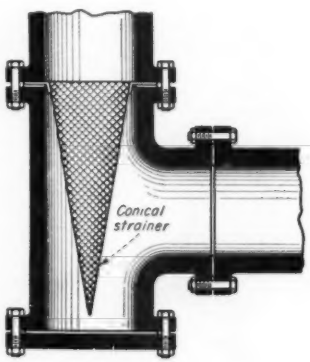
I should ask Mr Yarbrow to sit a Detroit, Mich., 1st-class Stationary Engineers License test. They have nice questions on water rates of turbines and engines. However Yarbrow should remember that not all the good engineers went to college. In fact 90% haven't been inside one. Majority rules.

But I want to see that steam piston-rod gland he packed with his felt hat. As for me, my hats are used for better purposes. Mainly protecting my balding head from the elements.

He's right on one thing though—license requirements are too easy. And the employers love it. They can hire a grocer to fire a boiler, or a candlestick maker to run an engine, but remember also that most states allow such antics. Why, if it wasn't for the insurance-company inspectors that most plant owners rely on, things would be a damned sight worse.

No wonder the Federal Government is backing up utility companies to build larger plants instead of building industrial power plants. The big winds in Washington just don't agree with the various license laws.

J M GORRIE *Sandston, Va.*



Conical Strainer Is Best

ON PAGE 109, April POWER, Ed J Duff shows us a strainer he used in a pipe tee. Some years ago, I made a similar strainer, but it was conical instead of cylindrical.

With a cylindrical strainer the mesh

covers the opening of the outlet pipe and considerably reduces its area, especially if the mesh becomes clogged with slime and trash.

With the conical strainer, shown in my sketch above, a much larger area of mesh is in use.

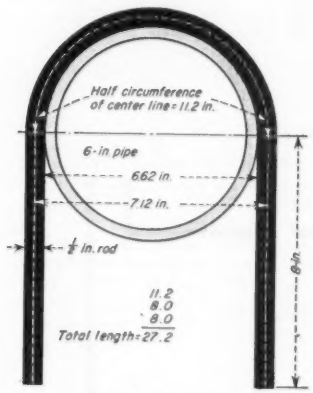
I installed the conical strainer where the upper vertical pipe could be unbolted and easily swung to one side for cleaning the strainer. In this case, the bottom cap was near the floor and hard to take off.

P H TROUT *Roanoke, Va.*

Bend U-Bolts On Paper First

ON PAGE 129 of May POWER, "Practical Ideas", G G Avant gives his method of measuring off and bending rods for U-bolts. He bends a piece of wire around a large pipe, snips off the straight sections at the desired length, then straightens out the whole wire and uses it to measure the right rod length. All he has to do then is thread the rod ends and bend to shape.

While it's a good idea I'd like to point out that using a wire in this way will make the U come out short—about ¾ in. short for a ½-in. rod. Wouldn't it be



just as easy, and more accurate, to figure the right length as shown in the sketch above?

When you bend the rod around the pipe the length of the centerline of the rod doesn't change. But the lengths of the inside and outside edges do. So if you get the right centerline distance and work with that, you'll come a lot closer to being right when you bend the rod.

The outside diameter of a 6-in. pipe is 6.62 in. This gives a diameter of 7.12 in. to the centerline of the rod. If you multiply this by 3.14 and divide by 2, you get 11.2 in. as the half circumference of the rod's centerline around the pipe. Then if each straight length of rod is 8 in., the total length of rod needed is 27.2 in.

J HOLT *Atlanta, Ga.*

EDITOR'S NOTE: *Instead of measuring the diameter and multiplying by* 3.14, *you can tape the circumference of the pipe, add* 3.14 *times the thickness of the rod* (½ *in.*) *then divide this sum by* 2 *to get the semi-circumference. For example, in this case, the pipe circumference would tape* 20.8 *in. Then* 3.14 × ½ = 1.6 *in. Then adding this to* 20.8 *gives* 22.4. *Dividing by* 2 *gives* 11.2 *in. for the semi-circumference. Adding this length to the two straight lengths of* 8 *in. gives* 2 × 8 + 11.2 = 27.2 *in.*

EDITOR'S BONER: We pride ourselves in producing an easily read magazine but in the May issue we really missed the boat. C G Harding's *Biggest Boner*, May p 132, wasn't too clear to us when it arrived. We tried a rewrite job and thought it read OK but when we saw it in published form we knew we had been guilty of a worse boner than CGH Here's how it should have read . . .

Our boilers operate at 150 psi. But if boiler feed pump fails we can feed boilers from city main or with water pumped at 60 psi from a nearby canal. Refrigeration condensers and air compressors are cooled by this canal water.

One day boiler safeties began to blow. The fireman thought boiler water was low so he opened the valve between boiler-feed and canal systems. There weren't any check valves in this line; hot water and steam from boiler, being at higher pressure, backed into it. The high-temperature water and steam flowed to our Freon condensers and air-compressor jackets. Freon pressure rose until relief valve opened and charge blew to atmosphere. Meanwhile air-compressor cylinders got red hot (high-temp boiler water again).

Real cause of trouble was boiler feed pump. It stuck on top center. With valve between boiler-feed and canal systems open, and no check valve to prevent backflow, higher-pressure water from boiler just shot into the line feeding refrigeration condensers and air-compressor jackets. You can be sure there's a check valve in that boiler-feed line now.

Credit Due

We don't want to overlook again giving credit to Virgil Brooks, Dallas, Texas, for his excellent "Facts on AC and DC," p 53, *Feb* OE—EDITOR.

Hot Drains from Boiler Gage Glass

I HAVE A SUGGESTION to make regarding "Why Boiler Gage Glass Showed False Level," p 132, April POWER.

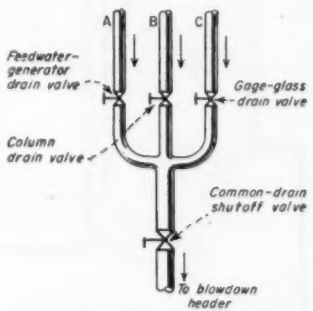
If there is a bad leak on the drain line from your gage glass, it's quite possible to top your boiler with water. And if the leak is serious enough, it could cause priming. Especially if your drain from the water column or gage glass leads to the blowdown header, because they're hard to notice.

At the beginning of each shift, before blowing or draining those lines, how about feeling above the drain valve to see if they are hot lines. If they are, there is bound to be a leak past the shutoff valve.

Sometimes on a tie-in to a blowdown line, it is not always permissible to work on these drain lines until they are isolated from blowdown or flash tank and boiler.

I think there should be a common shutoff valve for the column and water-glass drains. In case they leak through, close the common shutoff valve.

W WAINIKKA *Terrace Bay, Ont, Can.*

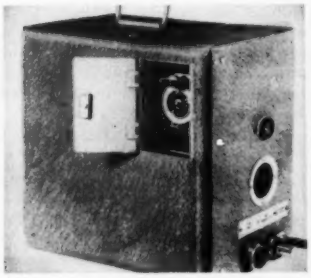


FEEL THESE LINES at *A*, *B* and *C*. If hot, they are leaking through. Then close the common shutoff valve at *D*

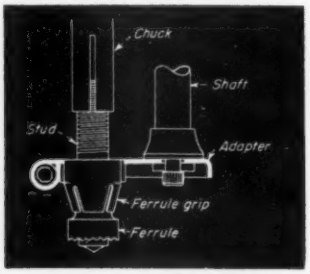
HOW TO SET UP FOR STUD WELDING

Photos courtesy Nelson Stud Welding Div, Morton Gregory Corp, Lorain, Ohio

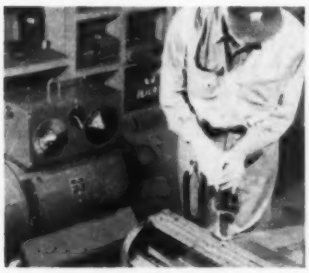
1 To operate this stud-welding gun, press trigger. Gun weighs five pounds



2 Timer unit controls weld cycle, depending on diameter of stud welded



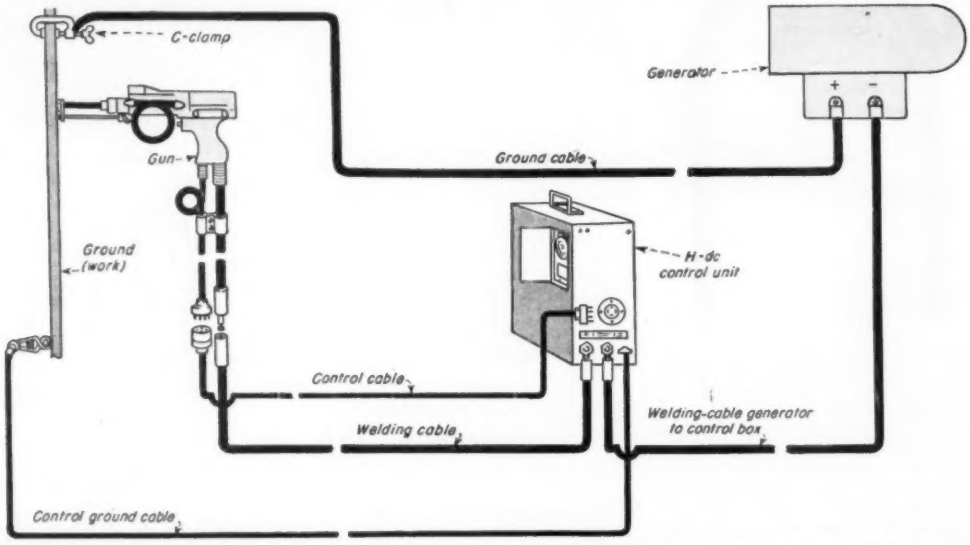
3 Right leg, foot and ferrule-holding rig for each job are attached to gun



4 Gun runs on this unit, batteries, dc welding generators or on rectifier

5 These granular-flux-filled studs are end welded in any position required

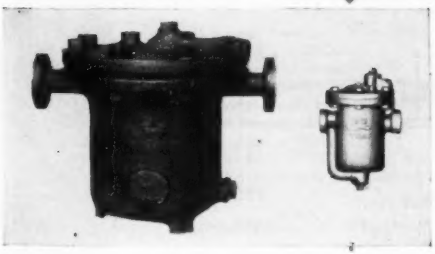
6 Fillet is evenly spread around stud base and studs solidly fused to work



7 Stud-welding gun, timer control unit and power source are coupled by welding cables. First step when preparing to stud weld is the correct assembly of these cables to the three units as shown. Now you are ready for doing some fast work

FOR BIG TRAP CAPACITY IN A SMALL PACKAGE ...buy Armstrongs

SIZE FOR SIZE THEY GIVE YOU MORE



FROM THE RIDICULOUS TO THE SUBLIME . . . The monstrosity on the left is a steam trap once manufactured in Germany. It weighs 116 lbs. but has no more capacity than the 10½ lb. Armstrong trap on the right. All of which is a means of focussing your attention on the importance of a steam trap leverage system. The size of the big trap is necessary due to its crude-by-comparison leverage design.

ARMSTRONG steam trap capacity is a bargain size for size because of the patented leverage system. In an Armstrong trap for 100 psig, leverage is higher than in one for, say, 15 psig. Thus, a larger valve can be opened than would be possible if the leverage was the same for all pressures.

That sounds simple, but isn't. If higher leverage is secured with a longer lever arm, a bigger trap body is needed. That's the trouble with the elephant shown at the left. Also the design must permit the valve to open *wide* or it will restrict the orifice, reducing capacity. *Armstrong's design answers these problems better than any other design.*

P. S. When comparing traps be sure capacities are based (as are Armstrongs) on *actual* tests with condensate at steam temperature. No other basis is reliable. ARMSTRONG MACHINE WORKS, 812 Maple St., Three Rivers, Michigan.

SEE OUR CATALOG IN SWEET'S

The 36-PAGE STEAM TRAP BOOK gives dimensions, weights and *actual* capacities of Armstrong traps. Write for a copy or Call your local Armstrong Representative.

ARMSTRONG STEAM TRAPS

HEADWORK

PHIL SWAIN BRINGS ENGINEERING THEORY DOWN TO EARTH

How Forces Balance—4

So far we have considered two general cases of balancing forces.

First, where all the forces intersect at a single point, there is no turning tendency. Forces intersecting at a single point are in balance when the force polygon or triangle is a closed figure. With this rule you can find the unknown force in a balanced setup.

Next come levers, where all rotation is around a fixed known pivot or axis. Here we find that the moment (turning effect) of any force is the product of the force by its lever arm. The lever arm is the distance from the pivot to the force *measured perpendicular to the line of action of the force.*

Now we come to a beam problem—finding the load on each support. Here moments are again involved. Note also that the forces are generally parallel (usually up and down). In these beam problems it isn't necessary to specify any particular point as a "pivot." You can choose any point you wish as an imaginary pivot. And no matter what point you select the right-hand moments measured from that point, will equal the left-hand moments.

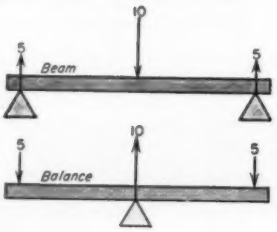
To convince yourself that this is true, start with the support loads figured in Fig. 4, and compute the right-hand and left-hand moments about any point selected at random. They will always balance.

This rule is the basis of many of the examples worked out in the captions.

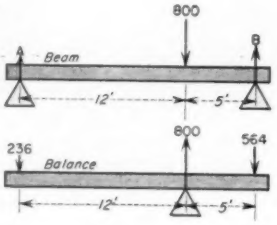
Also note that in any beam the total load on the two supports must equal the total load on the beam. The only problem is to find out how this total is divided between the two supports. Various methods are shown.

In all the problems pictured, the weight of the beam itself has been neglected. If it is important enough to consider, just add half the weight of the beam to the figured load on each support.

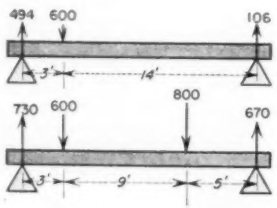
For tips on figuring the strength of beams with various common loadings, see Power Handbook, Part 1, page 85, as originally published in March POWER, 1951.



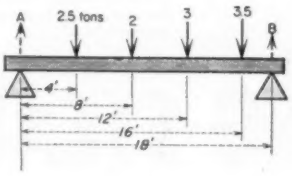
CENTER LOAD—for this center loading, or any other symmetrical loading, common sense tells us that each support must carry half of the load. If you turn the picture upside down (lower sketch) you get a balance or seesaw, but the answer is still the same



LOAD OFF CENTER—again common sense tells us that $A + B = 800$ lb. Also it's obvious that B is much greater than A. How much greater? Try balancing moments around the point where the 800-lb load is applied. Then $5\,B = 12\,A$, so $B = 12/5\,A$ or $2.4\,A$. Then $800 = A + B = A + 2.4\,A = 3.4\,A$, so $A = 800 \div 3.4 = 236$ lb. Then $B = 800 - 236 = 564$ lb



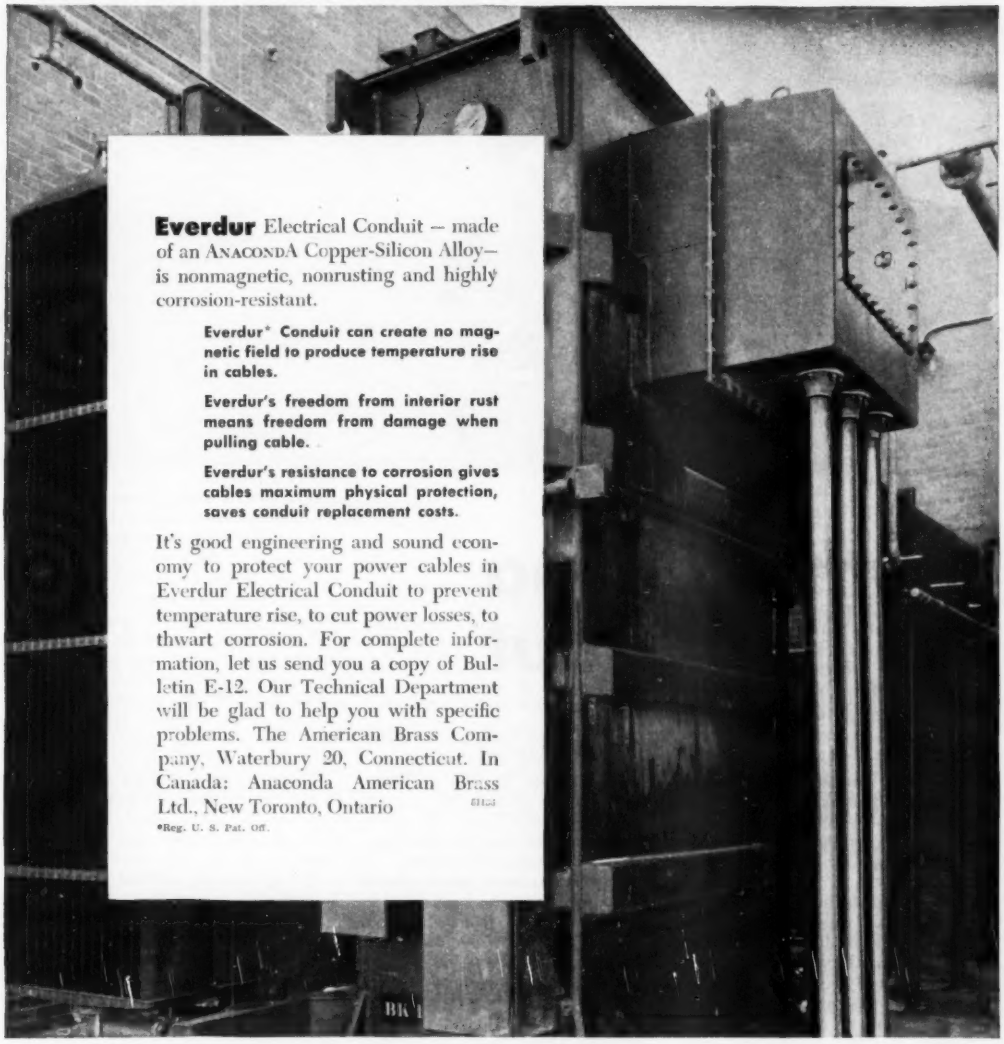
SEVERAL LOADS—one method is to figure the supports for each load separately, then add up. For the 600-lb beam load the support loads are 494 lb and 106 lb. For the 800-lb beam load the support loads have already been figured (Fig. 2) as 236 lb and 564 lb. Then we see (lower sketch) that the combined loads must give $236 + 494 = 730$ lb at left support and $564 + 106 = 670$ lb at right support



SEVERAL LOADS—here's another method, just as easy. First balance the moments around the left support as a center. This gives $18\,B = 2.5 \times 4 + 2 \times 8 + 3 \times 12 + 3.5 \times 16 = 118$ ton feet. So $B = 118 \div 18 = 6.56$ tons. Total of A and B must be $2.5 + 2 + 3 + 3.5 = 11$ tons, so $A = 11 - 6.56 = 4.44$ tons

EVERDUR—The non-ferrous cable conduit for full electrical and physical protection

Everdur Electrical Conduit installation to junction box of a 7,500 kva transformer at Dunkirk, N. Y., Steam Station of Niagara Mohawk Power Corp. Each conduit contains 1-conductor cable carrying 300 amperes at 13,800 volts. Separate conduits provide complete phase isolation.



Everdur Electrical Conduit — made of an ANACONDA Copper-Silicon Alloy— is nonmagnetic, nonrusting and highly corrosion-resistant.

Everdur* Conduit can create no magnetic field to produce temperature rise in cables.

Everdur's freedom from interior rust means freedom from damage when pulling cable.

Everdur's resistance to corrosion gives cables maximum physical protection, saves conduit replacement costs.

It's good engineering and sound economy to protect your power cables in Everdur Electrical Conduit to prevent temperature rise, to cut power losses, to thwart corrosion. For complete information, let us send you a copy of Bulletin E-12. Our Technical Department will be glad to help you with specific problems. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario

*Reg. U. S. Pat. Off.

wherever corrosion resistance counts — consider

EVERDUR ELECTRICAL CONDUIT

ANACONDA®

"I got in my model-T before breakfast and snooped around."

South Carolina Blowout

► MARMADUKE SURFACEBLOW hasn't been around the Bent Propeller Bar for some time. Scuttlebutt had it that he's helping out as night engineer in a neighborhood plant. So three of us got hot on his trail and tracked him down to an old brewery on 11th Ave here in New York City.

Sure enough, who should be making out the log book next to a huge old corliss-driven vertical ammonia compressor when we barged in last night but Marmaduke. It was hard to believe. There he was, gray bowler, checkered vest and all.

"Shades of 1890," yelped our Lou Rowley, yanking off his glasses and rubbing his eyes. "Old Surfaceblow looks more natural holding down that log desk than he does leaning against a bar."

"We're still getting mail about our smelly stationary engineers' license laws," I announced to Marmaduke, timidly. "Even those 32 pages on license requirements we printed last year are water on a duck's back. Absolutely nothing has been done to pass additional laws. What's the answer?"

Marmaduke ignored us completely and kept on writing. So I got up steam and added. "All the boiler insurance magazines come across our desk. Each month they run photos of wrecked plants, schools and apartment houses. The causes range from exploded flywheels to exploded hot water tanks.

" '$40,000 Loss And Boiler Had Latest Safety Devices,' says the first article in The Locomotive. '$9,000 Loss From Ammonia Compressor Wreck', says another. '$155,000 Loss From Vacuum-Collapsed Oil Tank,' says a third. 'Two Firemen Killed From Scalding Steam, reports still another."

"BILGEWATER ON LICENSE LAWS," roared Marmaduke, putting down his pencil. "IT'LL TAKE ANOTHER TWO-HUNDRED YEARS OF NEEDLESS DAMAGE TO IMPROVE CONDITIONS."

That's the reaction we had hoped for. We leaned back against the old flywheel guard. Marmy plopped down on the log desk, washed the soot out of his uptakes from a sweating pitcher of beer, and blasted away.

"Back in 1920 shipping was tough. The war was over and merchant ships were laid up in boneyards fast as they got to home port. So I packed my seabag in Baltimore and checked in at O'Callaghn's Waterfront Hotel & Bar.

"Two weeks later I had my tanks ballasted well enough so my landlegs could navigate a straight course. Before long I had a boiler inspector's job with an insurance firm and was on my way to South Carolina. They never heard of licensed engineers in that state. The things I ran into would drive a weaker man to drink.

"My first inspection was at a paper mill near Pulpburg. Mort Jackson owned the mill and had just installed two used hrt boilers and a new steam engine.

"The boilers came from an old sawmill, but were in fairly good shape. Before insuring this equipment, my job was to make a general survey and give the boilers a hydrostatic test.

" 'I want your engineer to stick close to me while I check the boilers,' I told Jackson. 'Maybe I can put him wise to a few things that might save you a shutdown some day.'

" 'Well now,' drawled Jackson. 'My old engineer kicked the bucket last week, so I ups and gave the job to young Bob Cuttner. Maybe you *can* put him straight on a few points. He's a good boy who's been firing here and I figure he's ripe for the engineer's job.'

"I didn't answer that but took young Bob in tow. He had been firing for only four months and I couldn't see how Jackson trusted him with his investment.

"By next afternoon I had all the information I needed down on paper. Then I made the internal and started the hydrostatic on the two boilers. Bob helped me fill those kettles up to the air cocks. Then I closed her valves and wedged the old ball and lever safeties. I raised the pressure to 150 psi with the feed pump while I inspected the seams for leaks. Just for good measure I showed Bob how to look for weeping tubes at the tubesheets. Thought that might get him more interested in the plant and save him headaches.

(*Continued on page* 200)

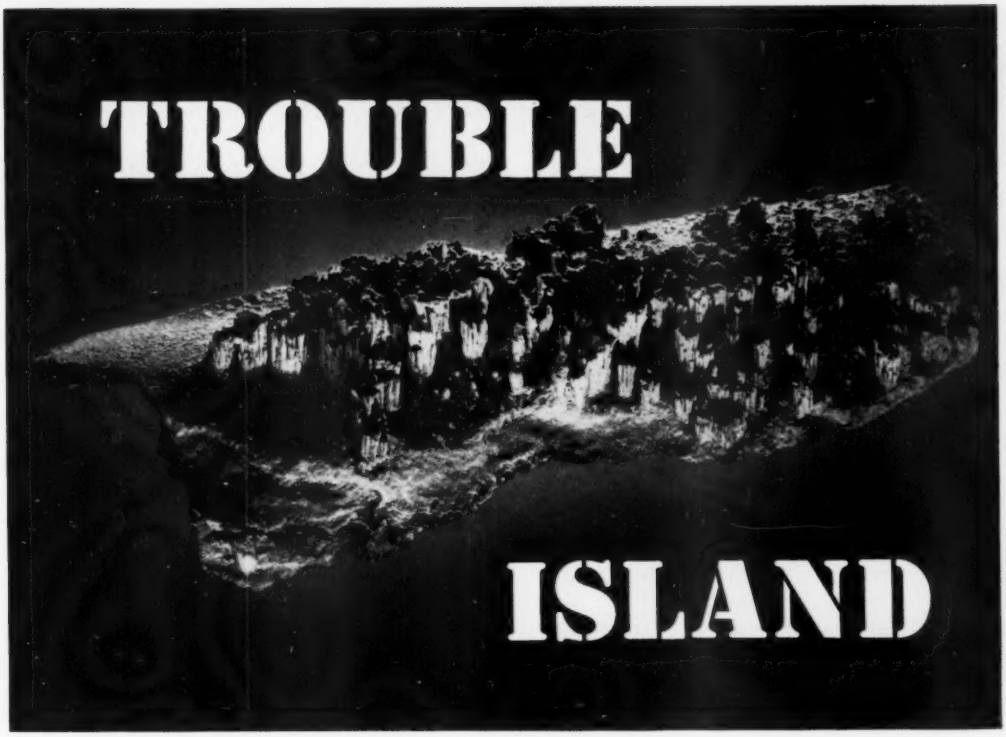


Photo is of a condenser-tube scale sample, about eight inches long. Solid scale is approximately ¼-inch thick, with "spires" ranging up to ⅜-inch height.

FIFTEEN years ago, this small island of trouble was part of a much larger open-box condenser problem at a refinery. Cooling water, running over 200°F. at outlet, contained 30 grains per gallon hardness and 20 parts per million iron. Tubes scaled heavily and rapidly without chemical inhibitor. Even with the best inhibitor then known, results were as illustrated above: partial inhibiting action creating the "spires" or forest-like deposits on tubes.

Considering this a challenge, Nalco sent a Doctor of Physical Chemistry — an expert water technologist — to the refinery. His weeks of work on the spot led to basically different treatment with new chemicals which cleaned up the condenser and kept it clean. Further Nalco research and development of chemical inhibitors has since enabled cooling systems to operate without scale or corrosion *with water hardnesses as high as 200 grains per gallon.*

Point is this: neither Nalco nor anyone else had an answer to scaling in that condenser. Nalco put the necessary brains to practical use and *got results* . . . benefiting, in the long run, not only that particular refinery, but every user of cooling water.

Whether your water treatment problem is unique, or stubborn plant-run, you will get prompt, decisive action from Nalco in the direction of positive results. Write or telephone today.

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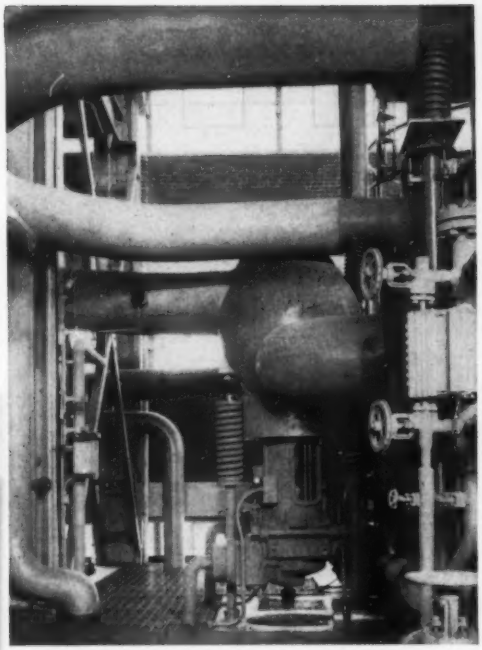
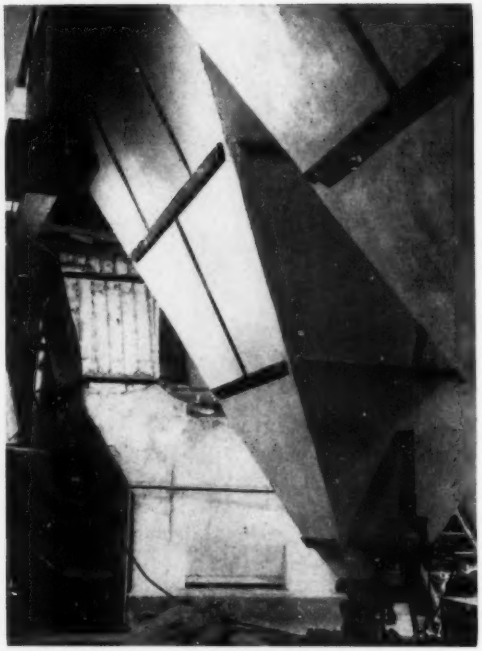


MERCURY PIPING, stop valves and inlet to mercury turbine have diatomaceous-silica and 85%-magnesia heat insulation



PRECIPITATOR hoppers and induced-draft fan housing are insulated with 85% magnesia, have cement and canvas finish

Insulation Cuts Mercury-Unit Losses

► SCHILLER STATION at Portsmouth, of the Public Service Co of New Hampshire, is the first central station fitted with standard mercury-steam units (see POWER, Mar 1950, pp 76-84). Two standard-design 7500-kw mercury units working in parallel supply steam to a conventional 25,000-kw steam turbine-generator, making an integrated unit with a total capacity of 40,000 kw. Insulation in this plant does its bit to keep heat rate low; thicknesses chosen reduce radiation losses to an economic minimum; special application methods and thicknesses are used for the mercury boilers.

Insulation. Diatomaceous silica and 85% magnesia, separately or in combination, insulate piping, boilers, turbines and auxiliary equipment. Use of the two takes advantage of high temperature resistance of diatomaceous silica and the low heat conductivity of 85% magnesia.

Sectional or segmental covering is used on pipes, depending on size. Blocks, cut and mitered, insulate valves and fittings. All joints, cracks and voids are sealed with insulating cement. This gives airtight fit, prevents scorching of finish. Asbestos-paper jacket and 8-oz canvas, which is sewed in place, cover most pipes. Some large-diameter pipes are finished with a smooth coat of asbestos cement troweled on.

To prevent charring the canvas, a glass-cloth finish adjacent to saddles, hangers, supports and anchors is used on insulation applied to mercury-vapor pipes at 975 F.

Equipment. Boilers, turbines, heaters, flues, ducts and casings are covered with insulating blocks. Tie wires, anchored to angles, clips or studs previously welded to equipment surfaces, hold blocks in place. Circumferential angles and bars support insulation, prevent slippage. Manhole covers, access doors and removable waterbox covers are separately insulated so they can be taken off without disturbing the main portion of the covering. Metal beading strips protect insulation on duct corners.

Sewed and pasted canvas jacket applied over base of asbestos cement, reinforced with wire-mesh netting, is used on equipment other than boilers. Resin adhesive in place of sewed canvas on irregular surface gives smoother finish.

Boilers. Finishes on boilers vary, depending on location of surface, operating temperatures and conditions insulation is exposed to. For welded, flanged or bolted-casing finishes, asbestos rope barriers are stapled horizontally to the insulaion at each buck-stay, and vertically where needed. High-temperature cement, asbestos cement, asphaltic-asbestos plastic and canvas are other finishes.

Superheater walls and roof have shop-fabricated, removable panels of No. 10 BWG plate, packed with block insulation. Sides of panel slide over angle-iron supports welded to the boiler steel-work.

Flanges. All pipe and equipment flange insulation is easily removable without damage to adjacent covering. Joint insulation is made of preformed sections as well as blocks.

Power House and Process Piping at new 60-acre Pfizer Plant equipped for years ahead with

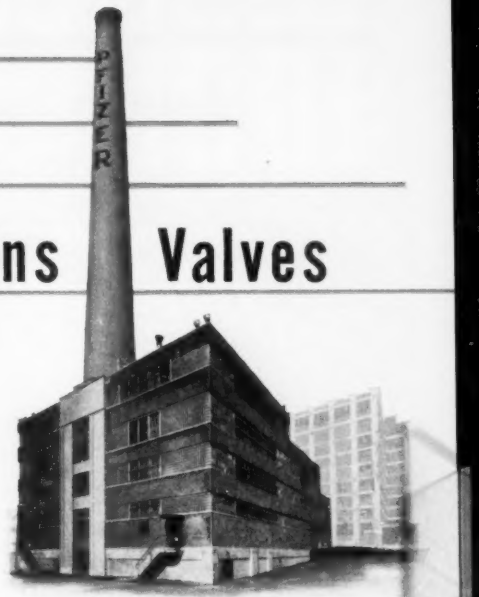
Jenkins Valves

At Groton, Connecticut, the new plant of Chas. Pfizer & Co., Inc., provides additional capacity to meet mounting demands for this company's fine chemicals and antibiotics.

In Pfizer's continuous process manufacture of these products, the dependability of the heat and power supply is vital. That is why you'll find Jenkins Valves in the new power plant, and, in fact, throughout the intricate network of process pipelines.

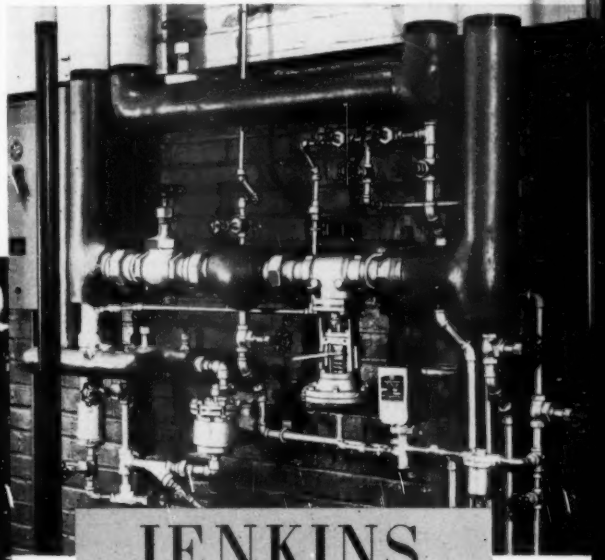
Because the power demand is endless, it requires—even in normal times—unfaltering efficiency of all component equipment. And because operating economy depends on *continued* efficiency in the years ahead, Jenkins Valves have long been the choice of the men who plan, build, operate, and maintain the nation's vital power installations.

They know that Jenkins builds *extra* endurance into valves. Yet despite this *extra* value, *you pay no more* for Jenkins Valves. For new installations, for all replacements, let the Jenkins Diamond be your guide to lasting valve economy. Jenkins Bros., 100 Park Avenue, New York 17. Jenkins Bros., Ltd., Montreal.

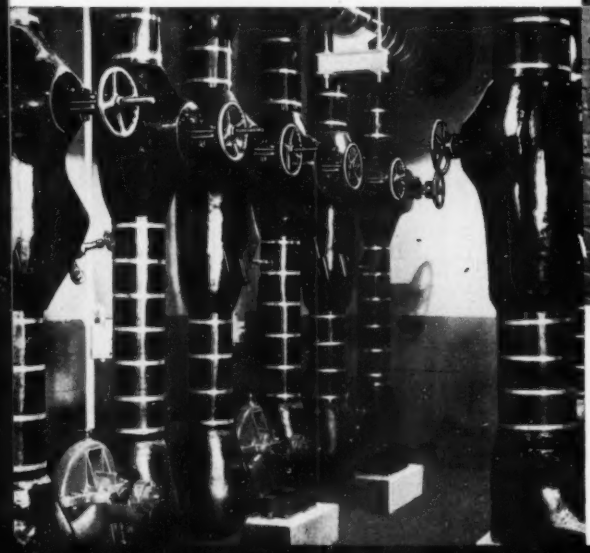


General Contractors, W. J. BARNEY CORP. Piping Contractors, J. H. MERRITT CO.

Some of the Jenkins Valves installed in the Pfizer power plant. Its rating is 230,000 lbs. per hour from two oil-fired boilers.



Large Jenkins Gate Valves on pipelines serving the 12-step Pfizer process of synthesizing a stable form of crystalline Vitamin A, the first produced on a commercial scale.



JENKINS VALVES

LOOK FOR THE DIAMOND MARK

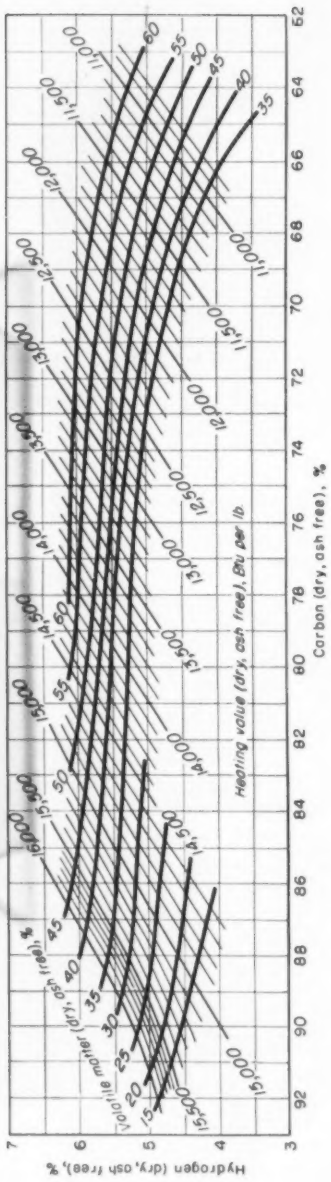
SINCE 1864 TRADE JENKINS MARK

SOLD THROUGH LEADING INDUSTRIAL DISTRIBUTORS EVERYWHERE

POWER'S DATA SHEET

NUMBER 229

Converting Proximate to Ultimate Analysis



► THIS CHART gives good results for the great bulk of coals used in steam generation. Its accuracy falls off with anthracite, cannel, and coals containing unusual amounts of resins and waxes.

Here's how this chart is used; first list:

Proximate Analysis—As Received	
Moisture, %	1.8
Volatile matter, %	38.0
Fixed carbon, %	52.3
Ash, %	7.9
Total, %	100.0
Sulfur, %	2.4

Heating value, Btu per lb 13,770

Proximate Analysis—Dry Basis	
Volatile matter, %	38.7
Fixed carbon, %	53.3
Ash, %	8.0
Total, %	100.0
Sulfur, %	2.4

Heating value, Btu per lb 14,040

Proximate Analysis—Dry, Ash Free	
Volatile matter, %	42.1
Fixed carbon, %	57.9
Total, %	100.0
Sulfur, %	2.7

Heating value, Btu per lb 15,260

Locate intersection of dry, ash-free volatile matter and Btu lines on chart, 42.1 vs 15,260, and find this corresponds to 84.9% carbon and 5.8% hydrogen. Assuming 1.5% N_2 for dry, ash-free condition build up ultimate analysis:

Ultimate Analysis—Dry, Ash Free		
C %	84.9—0.7	84.2
H_2 %		5.8
N_2 %		1.5
S %		2.7
O_2 %		5.8
Total		100.0

Sulfur correction to carbon is ¼ of sulfur, dry, ash-free percentage. Oxygen is figured by difference.

Using dry-ash percentage from proximate analysis, convert to dry basis by multiplying above by 1.00-0.08 or 0.92, and get:

Ultimate Analysis—Dry Basis	
C %	77.45
H_2 %	5.34
N_2 %	1.38
S %	2.48
O_2 %	5.35
Ash, %	8.00
Total, %	100.00

Next step multiplies each item by 1.0 minus moisture (1.00-0.018) to get:

Ultimate Analysis—As Received, Separate Moisture	
C %	76.0
H_2 %	5.2
N_2 %	1.4
S %	2.4
O_2 %	5.3
Ash, %	7.9
Moisture, %	1.8
Total, %	100.0

If desired, moisture may be distributed to H_2 and O_2 items by assigning 1/9 of moisture percentage to H_2 and 8/9 to O_2:

Ultimate Analysis—As Received	
C %	76.0
H_2 %	5.4
N_2 %	1.4
S %	2.4
O_2 %	6.9
Ash, %	7.9
Total, %	100.0

Heating value, Btu per lb 13,770

WE HAVE CHECKED THIS METHOD AGAINST LABORATORY ANALYSES FOR MANY COALS; HERE ARE SOME RESULTS:

Producing Area	Proximate Analysis, As Received						Ultimate Analysis, As Received					
	Moist	*VM*	*FC*	*Ash*	*Sulf*	*Btu*		*C*	*H_2*	*O_2*	*N_2*
Penn.(1)	2.2	16.2	72.1	9.5	2.1	13,710	Actual	79.2	4.4	3.4	1.4
							Calc	79.4	4.5	3.2	1.3
Penn.(2)	3.3	34.4	54.1	8.2	1.1	13,380	Actual	74.5	5.3	9.4	1.5
							Calc	75.0	5.3	9.0	1.4
W. Va.(1)	3.3	16.0	76.1	4.6	0.6	14,450	Actual	83.9	4.6	5.2	1.1
							Calc	83.7	4.7	4.9	1.5
W. Va.(2)	1.8	38.0	52.3	7.9	2.4	13,770	Actual	76.0	5.2	7.1	1.4
							Calc	76.0	5.4	6.9	1.4
Ky.(1)	3.6	37.2	56.5	2.7	0.7	14,220	Actual	79.6	5.5	9.9	1.6
							Calc	79.6	5.7	9.8	1.5
Ky.(2)	3.4	37.4	54.8	4.4	1.0	13,800	Actual	77.4	5.5	10.2	1.5
							Calc	77.6	5.6	9.9	1.5
Ill.	9.2	33.8	48.6	8.4	0.9	11,930	Actual	67.3	5.5	16.3	1.5
							Calc	67.1	5.6	16.7	1.3
Colo.	14.4	38.4	41.2	6.0	0.8	10,600	Actual	60.6	5.8	25.6	1.2
							Calc	60.2	6.1	25.6	1.3
Tenn.	5.1	36.3	55.8	2.8	1.0	13,570	Actual	76.5	5.6	12.2	1.9
							Calc	76.4	5.6	12.7	1.5
Iowa	16.6	36.5	37.4	9.5	4.3	10,480	Actual	57.4	6.0	21.8	1.0
							Calc	57.6	6.1	21.3	1.2
Alaska	10.7	30.4	44.0	14.9	0.7	9,640	Actual	55.3	5.0	23.6	0.6
							Calc	55.5	5.2	22.5	1.2

E O SMITH, *Asst Mgr, Inspection Dept, Eastern Gas and Fuel Associates*

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Another NORDBERG FIRST

the Supair Thermal Engine

THE MOST OUTSTANDING DEVELOPMENT IN MODERN DIESEL DESIGN

featuring:

- ★ ONE-THIRD MORE HORSEPOWER THAN CONVENTIONAL TURBO-CHARGED ENGINES
- ★ MORE HORSEPOWER IN LESS SPACE
- ★ MORE HORSEPOWER PER GALLON OF FUEL
- ★ MORE HORSEPOWER HOURS PER GALLON OF LUBE OIL
- ★ INCREASED THERMAL EFFICIENCY
- ★ LESS HEAT LOSS TO WATER JACKETS
- ★ LESS WEIGHT PER HORSEPOWER
- ★ LOWER INSTALLATION COST
- ★ LOWER OPERATING COST
- ★ LOWER MAINTENANCE COST

The *SUPAIRTHERMAL* Engine, the outstanding engine of the Diesel field, is available in a complete range of 4-cycle types for fuel oil, Duafuel, or spark ignition gas operation . . . for all applications, in sizes from 425 to 3200 B.H.P.

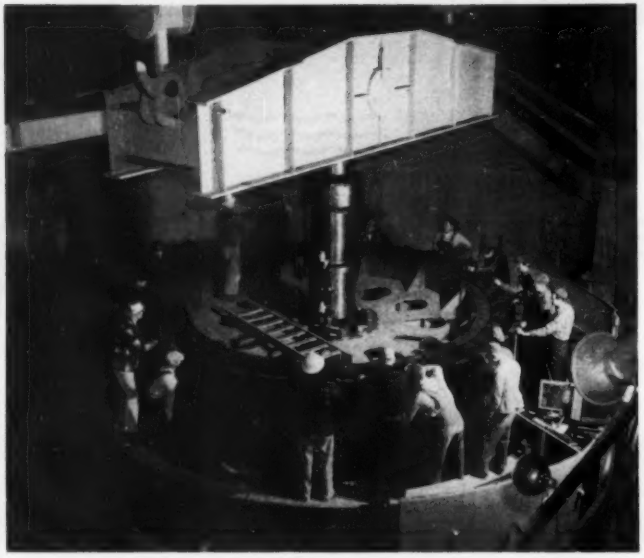
Write for further information on the *SUPAIRTHERMAL* Engine . . . the most outstanding development in a long line of famous Nordberg "FIRSTS".

NORDBERG MFG. CO.
Milwaukee 7, Wis.

NORDBERG
DIESEL ENGINES

READER SERVICE SECTION

POWER NEWS 154
TECHNICAL BRIEFS 156
PLANT EQUIPMENT NEWS 160
NEW FREE BULLETINS 169



World's Largest Motors Go Into Service

Two giant 65,000-hp GE synchronous motors, weighing more than 330 tons per motor, second to none in power and size, will drive two pumps, each capable of supplying New York City's daily water requirements, at the Bureau of Reclamation's Columbia Basin Irrigation Project. Photo above shows the rotor being set in final position

Atomic Power—Around the Corner?

► On May 1, Monsanto Chemical Co installed a new president, Dr Charles Allen Thomas, one of the top executive-scientists in the development of the atom bomb. His experiences in this development have left him with a strong leaning towards atomic energy as a power source. He first voiced this leaning at a college commencement address a year ago last June.

Chief obstacles to any atomic-power plant today are: (1) the plant would take critical uranium from the government's atom-bomb program. (2) Costs would run about two to three times as much as a coal- or oil-fueled plant.

Thomas feels he has the answer to both objections. Monsanto's plant would receive uranium from the Atomic Energy Commission as a primary fuel. It would then transmute uranium to plutonium and use the temperatures generated in the process to heat steam. From there a standard steam turbine would produce electric power.

Since the A-bomb project needs both uranium and plutonium the program would not suffer by this conversion of uranium. The AEC would retain possession of the uranium and plutonium at all times.

As for the high cost of building Thomas believes the AEC can be expected to pay a fee for the plutonium-making process. The moneys realized from this Monsanto service will help amortize plant-construction costs under a 10-year contract.

Right now Monsanto is running a survey of recorded data to find out if such a plant is possible. The theory is pretty well established, but the practical problems of metals and materials for such service plus production costs compared to Hanford's plutonium plant are yet to be answered. The survey is expected to last six months. If results indicate a plant can be built, Thomas thinks a 75,000-kw installation should take only two to three years to complete.

Biggest question mark, if all turns out well, is the government's attitude. The AEC has given the survey a green light but makes no guarantee it will permit construction of a power plant.

Storage Battery Information Plan

Gould National Batteries Inc has launched a special plan, called the "Plus-Performance Plan." It consists of an integrated conservation program based on applicable charts, manuals, and articles pertaining to particular users' problems.

Battery performance can be improved as much as 50% if four major rules are practiced properly:

1. *Selection:* Buy batteries to fit the job. Purchase of oversized or undersized batteries wastes man-hours, money or materials.

2. *Charging and handling:* Charge batteries correctly. Watch the rates of initial and finish charges. Equalize when necessary. Install batteries correctly. Connect them properly. Ventilate adequately. Handle according to printed instructions.

3. *Maintenance:* Maintain batteries systematically. Organize a foolproof maintenance program. Tighten loose connections and replace worn cables. Use batteries within designed capacities. Over-discharge cuts down performance.

4. *Determination of condition:* Test batteries regularly. Keep a record of cell readings. Know the conditions of batteries at all times. Replace batteries when necessary. Knowledge of battery condition permits ordering far enough ahead to assure continuous service.

To assist battery users to apply these four points easily Gould has prepared the

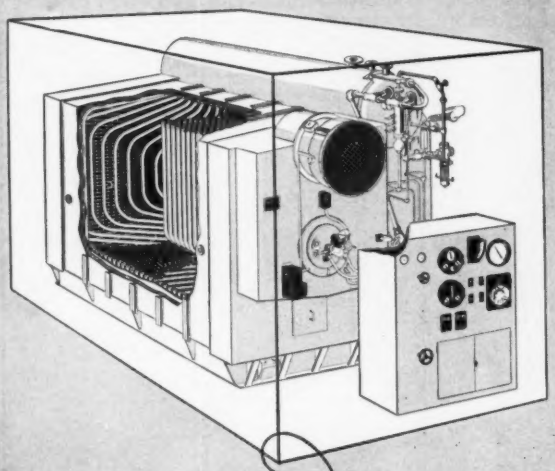
(*Continued on page* 206)

FOR MORE NEWS . . .

. . . of the power field, see the items on pp 226-228. Also, Coming Events for this issue appear on page 206, Appointments are on page 220.

get your steam

3,500 to 25,000 lb per hr



B&W Integral-Furnace Boiler, Type FM

- in this
- NEW
- shop-
- assembled
- unit

note these **cost-saving** features

- Saves Erection Time and Cost
- Meets Wide Range of Services
- Handles Quick Load Changes
- Fast Steaming
- Low Maintenance
- Easy Accessibility
- Suitable for Outdoor Service
- Burns Oil and/or Gas
- Saves Fuel
- Saves Space
- Safe, Automatic Operation

Send for Bulletin G-72, detailing the many advantages of this new B&W creation in low-cost steam generation. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.

Helping Industry Cut Steam Costs Since 1867

BABCOCK & WILCOX

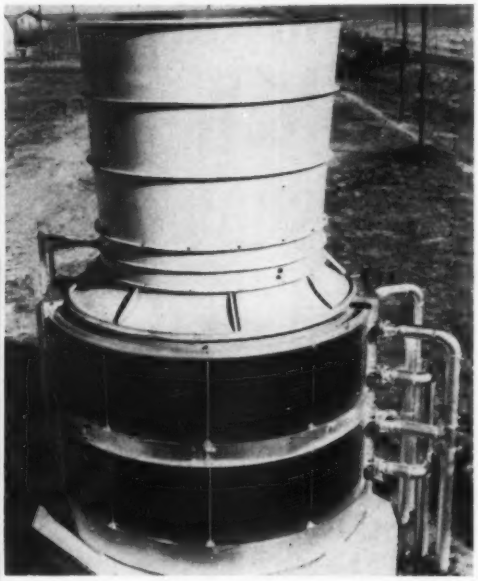
G-534

TECHNICAL BRIEFS

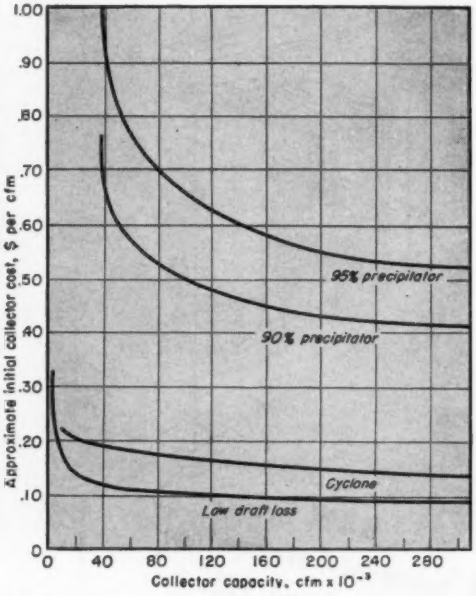
Latest engineering developments for busy power men

12 digests for you on:

WATER CONSERVATION
AIR POLLUTION
WATER TREATMENT



1 Air-cooled heat exchanger serves well for cooling process water in areas of high-cost or undependable water supply



2 Dust-collector devices differ in cost as well as in best field of services. Curves above give cost comparisons

Water Conservation

WATER CONSERVATION, *by R C Kelly, J F Pritchard & Co.* Use of water by established basic industries has increased over 40% in the past decade. Of the total consumption in the average large industrial plant, 53% goes for cooling purposes; 31 for process; 8, boiler feedwater; 5, sanitary purposes; about 3 for miscellaneous demands.

Plants depending on surface water or underground water constitute about 96% of total installed industrial capacity. Our present production of energy comes 50% from coal, 32 from oil, 14 from natural gas, and 4 from hydro plants. In the average steam-turbine plant, 92% of the water used is for condenser cooling.

The power industry has been engaged in increasing its plant capacity ever since the close of the last war. Projected plans call for a gross generating capacity increase of about 5 million kw per year for each of the next ten years, according to the author. This could well mean a new water consumption of 10 million gpm.

Available water supplies in the areas experiencing the most rapid industrial growth are at the stage where considerable planning is needed. To get the most effective use from available waters, some form of heat-exchanger device should be adopted. These devices can cover everything from spray ponds, evaporative coolers, atmospheric draft-type cooling towers, forced-draft cooling towers, or the more popular induced-draft cooling tower. For each pound of water evaporated, about 1000 Btu of waste heat is dissipated into the atmosphere. In power plant heating, efficient condenser-water cooling results from the circulation of eight to ten gallons for each 1000 Btu heat dissipation. *MWP paper, no number.*

Directions for ordering papers are given on page 158

PROBLEMS RELATING TO OPERATION, MAINTENANCE AND CHEMICAL CONTROL OF COOLING TOWERS, *by V F Estcourt, Pacific Gas & Electric Co.* For steam electric-generating stations cooling-tower performance must be considered in terms of heat dissipation as well as in relation to over-all results with a particular combination of tower condenser and turbine. There is an important relationship between turbine leaving losses and optimum power size.

The author approaches the subject not only for economic size of tower, but also for certain operating problems. For instance, the problem of condenser tube scale deposits is more likely to

(*Continued on page* 158)

Need special high pressure gaskets such as these?

Flare-type Gasket with Bellows Action

Delta Joint Gasket

Pressure Seal Joint Gasket

We tailor them to your specifications

If you require high pressure gaskets made to extremely close tolerances—for service exceeding 10,000 psi, for example—and fabricated to any desired diameter or cross-section, why not look into the special service that Goetze offers for making these gaskets to your order.

The gaskets shown above are typical of the wide variety for high pressure service that have been made to order for Goetze customers. The flare type gasket with bellows action illustrated at upper right is but one example of what Goetze "know-how" can accomplish.

Goetze has had over sixty years of experience in making specialized metallic gaskets for industry's most complex jobs. Modern machines—many of them specially designed and built by Goetze—enable Goetze craftsmen to produce gaskets of any required design, shape or size... and deliver them with remarkable promptness.

For further information about Johns-Manville Goetze gaskets, write for a copy of the new Goetze Gasket Catalog. Or send us a drawing or template for assistance on your specific problem. Address Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville Goetze GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE.

More TECHNICAL BRIEFS

Begins on page 156

become critical where cooling towers are used because of the higher cooling-water temperature.

Various water-treatment methods are described as far as results are concerned. Success is possible with a threshold treatment of cooling-tower water with stabilized phosphate in combination with sulfur burning to keep condensers free of scale deposits. The problems of recirculation, fan-blade failures, and noise nuisance are discussed. *ASME paper No. 51-S-10.*

PUMPED STORAGE, *by W J Rheingans, Frank Jaski and Herman Roth, Allis-Chalmers Mfg Co.* Pumped storage consists of storing water by pumping into specially constructed or natural reservoirs for the purpose of using this water later for power generation. The true pumped-storage project takes water from a river, lake or reservoir and pumps it to a reservoir at a greater height. Its advantages are that it: (1) uses surplus power available during the night and on Sundays or other off-peak periods (2) assists in running thermal stations at continuous uniform load (3) adds to the system's capacity reserve.

Recent research work has promoted the use of a reversible turbine pump in such pumped storage projects where a single runner hydraulic unit operates in one direction as a pump and in the other as a turbine. The hydraulic unit connects to a single electrical unit serving as a motor for pump operation and a generator for turbine operation. Maximum efficiencies approach closely those of standard pumps and turbines. *MWP paper. No number.*

SURVEY OF CURRENT PRACTICE IN TREATMENT OF COOLING WATER, *by Durando Miller, Permutit Co, New York, N. Y.* Increased attention has been focused upon treatment of industrial cooling water because (1) shortages have forced maximum reuse of that water (2) alloys for cooling systems have become limited in general availability.

Cooling towers have begun to play a large part in the reuse of such water. Since they depend upon evaporation for their cooling effect, minerals in the water remain behind and increase in concentration within the tower. Water softening by either zeolite or lime process is widely practiced to eliminate difficulties from mineral scale deposits.

Preventing oil scale, however, introduces a different problem. Corrosion due to oxygen absorbed from the air by water, and the effects of this corrosion on the steel surfaces, demands a more highly developed water-treatment method. *MWP paper. No number.*

Air Pollution

RECENT IDENTIFICATION OF ATMOSPHERIC CONTAMINANTS IN THE LOS ANGELES SITUATION, *by G P Larson, Los Angeles County Air Pollution Control District.* Air-pollution control is now concerned with a new field of combustion, which the author calls "cold" combustion in the atmosphere. Here, photochemical reactions, with certain organic contaminants, produce a smoke-like haze and irritating vapors. The reactive products for such a photochemical action must be controlled at the source in areas where their harmful effects can be demonstrated. Their biggest danger, of course, is to plant life.

Los Angeles County has made considerable efforts to measure the contaminants and identify them for both character and, eventually, the nature of their action. *APSPAA paper, no number.*

DESIGN OF A LARGE MODERN STACK, *by G B Williamson, Union Electric Co of Missouri.* Air-pollution control has added three requirements for the designer of a power-plant stack to meet in laying out the necessary power plant for today's operations. Originally, all he had to concern himself with were smoke-stack design and then construction. Today, however, he must (1) make an analysis of the effects of stack height and exit-gas velocity on the atmosphere (2) resolve the height requirements to meet aviation limits (3) forecast by judgment how the completed stack will fare under future local ordinance changes on allowable stack emission.

Estimated stack-draft losses for a modern, large, central-station power plant run 9.9 in. water for boiler, 0.46 for soot hopper, 0.4 for gas ducts, 0.36 for dust collector, 0.4 for inlet loss in the collector, 0.75 for stack (12-ft dia), 0.44 for leaving loss, and an allowable 30% margin of 3.5 in. wg, so the total induced draft needed runs 16.2 in. of water.

The author then discusses the choice among the various materials, a discussion of first cost and additional operating cost estimates, the value of stack lining, cleanout provision, and installation of stack lighting for aviation warning. *APSPAA paper, no number.*

ECONOMICS OF FLYASH COLLECTION, *by C A Gallaer, Buell Engineering Co.* Installation of flyash collectors in any particular plant should always be studied as an individual problem since it may very well be the exception that proves the rule. But there is an overall pattern for classifying a specific flyash problem. And from this point you can roughly predict the cost of collecting a designated percentage of total dust. Very early in the decision to use a dust collector, some consideration should be given to the range of minimum and maximum efficiency desired. The very minimum would be set by any local ordinance or any proposed possible local ordinance. The maximum will, of course, depend on the extent of cleanup the plant desires. Actually, too efficient an installation is a luxury, and the extra cost of the excess efficiency may not be justified.

The author describes the major classes of flyash, the four general types of industrial dust collectors, the differences between the low-draft loss collector and the high-efficiency cyclone.

Next, he discusses the efficiency characteristics of mechanical collectors and electrostatic precipitators. Figures (p 156, No. 2) show efficiency curves of a typical low-draft loss collector, a cyclone, and for comparison a 90% over-

(*Continued on page* 208)

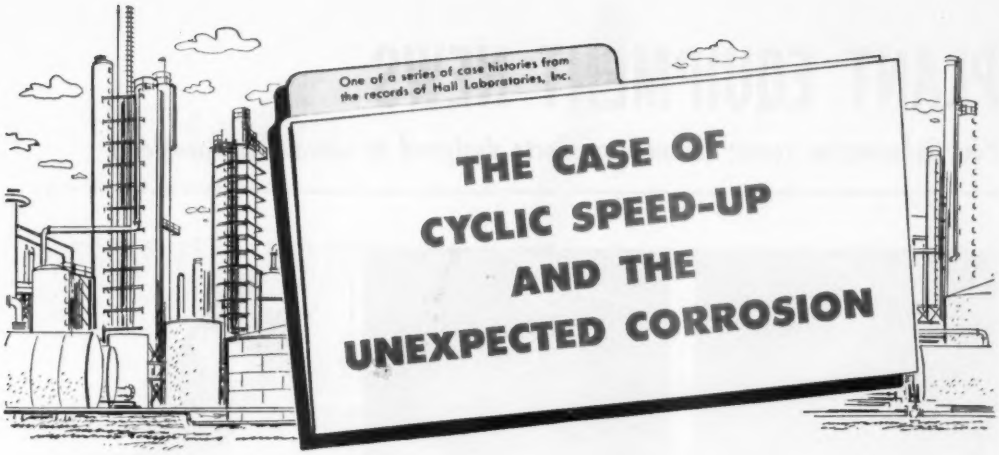
TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from one of the following sources. Order complete paper from source, not from POWER.

Midwest Power Conference, Sherman Hotel, Chicago, Ill. April 2-5, 1951. Identified by initials MWP. Obtainable in procedures. Inquire R A Budenholzer, Illinois Institute of Technology, 3300 Federal St, Chicago 16, Ill.

American Society of Mechanical Engineers, spring meeting, Atlanta Biltmore, Atlanta, Ga. April 2-5, 1951. Identified by initials ASME. Obtainable through ASME, 29 W 39th St, New York 18, N. Y.

Air Pollution and Smoke Prevention Assn of America, Hotel Roanoke, Roanoke, Va. May 6-10, 1951. Identified by initials APSPAA. Obtainable in procedures. Inquire R T Griebling, secy, 4400 Fifth Ave, Pittsburgh 13, Pa.



One of a series of case histories from the records of Hall Laboratories, Inc.

THE CASE OF CYCLIC SPEED-UP AND THE UNEXPECTED CORROSION

This industrial process involved thermal refining of a vegetable oil. The batch-processing plant functioned by shooting steam through a heat exchanger, following this with water for cooling. So to process more oil without building a new plant, the hot-to-cool cycle had to be repeated more times per day.

The plant Engineering Department worked out a method of speeding up the cycle by using extended-surface tubes in the exchangers. For a time, the new system worked well but soon production slumped because of repeated failures due to corrosion.

The men in the Engineering Department had relied for years upon the Hall System of Boiler Water Conditioning in connection with the power plants of the company. They knew, furthermore, that Hall Laboratories had broad experience with all kinds of industrial water problems. So they brought their new problem to Hall for a cooperative appraisal.

On the basis of the facts presented, Hall engineers at headquarters suggested both mechanical changes—improvement of deaeration and redesign of headers to get better flow—and chemical treatment—a few parts per million of amine in the steam, a few parts per million of Calgon in the water. In the field, Hall engineers followed through by checking actual conditions at intervals. As a result of this complete engineering approach, corrosion was greatly reduced and the processing units now stay in production.

Let Hall Laboratories tackle your specific water problems. Clip the coupon for more information.

HALL LABORATORIES, INC.

(A SUBSIDIARY OF HAGAN CORPORATION)

CONSULTANTS ON BOILER WATER CONDITIONING;
PROCUREMENT, TREATMENT, USAGE AND DISPOSAL OF INDUSTRIAL WATER

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.
Please send me your bulletin: Let's Consider Your *Whole* Water Problem.

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P-7

PLANT EQUIPMENT NEWS

Your information center for new products designed to solve plant problems

Published monthly as a service to readers

CARBON AND STAINLESS STEEL weld faster with new sigma welding process. Drops form, *right*, 50 times as fast as they do in usual pure argon atmosphere, left

FASTER WELDING AT LOWER CURRENT DENSITIES P710

The speed of shielded inert-gas-metal arc welding of stainless and carbon steel can be stepped up considerably with the new Linde argon-sigma welding process. Research has established that under the best welding conditions the metal transfer consists of a series of metal droplets propelled at high velocity. Rate of droplet formation varies with different metals and different current densities.

By adding small percentages of oxygen to highly purified argon the droplet rate increases greatly. Rate of increase in this mixture has been as much as 50 times more with other conditions remaining the same. This tremendous increase with no change in current density permits welding at higher speeds without fear of undercutting. What's more, coalescence of weld metal improves with the increased welding speed. With it, overhead welding of stainless steel becomes practical.

If desired, the older rates of welding can be kept and the current densities greatly reduced. This means larger-diameter lower-cost rods can be used for a given welding current, or thinner materials can be welded with the older size rods.

The required oxygen-argon mixture sells under the name of Linde argon-sigma grade.

Linde Air Products Co, Union Carbide & Carbon Corp, 30 E 42nd St, New York 17, N. Y.

HAND PUMPS P761

Built in 7, 10, 14 and 28 gpm sizes, these rotary hand pumps have suction and discharge pipes for drum and skid tanks. They have return drip pans for barrel mounting, floor stand for underground tanks, and brackets for wall or foot mounting.

Smaller sizes are direct crank-driven, and larger sizes gear-driven. Large sizes are swinging-vane type that give nonpulsating flow and smaller sizes are sliding-vane type. All vanes are self-adjusting for wear. Bulletin available.

Blackner Pump Co, 1809 Century Ave, Grand Rapids, Mich.

REFRACTORY COATING P743

New liquid refractory coating dries to a diamond-hard finish that expands and contracts with the brick under heat conditions so it does not flake or crack off.

Power Chemicals Div, E F Drew & Co, Inc, 15 E. 26th St, New York 10, N.Y.

For more data on these items, use post cards, p169. Identify request with P and number.

And Next Month . . .

Blowdown valve that safely holds correct boiler water concentration by continuous blowdown. Unit eliminates intermittent manual boiler blowdown. Valve can be quickly dismantled without breaking pipe joint. Flow rate is adjustable over a wide range. There are no inaccessible, cloggable, crevices.

SPLIT-CORE PF METER P719

Hook-on pf instrument that permits direct measurement without cutting conductors or interrupting electrical service. This instrument, Type AK-3, may be used on any balanced 3-phase circuit. It gives direct readings in circuits with voltages ranging from 100 to 600 and currents from 15 to 600 amp.

It is designed for industrial plants where maintenance of high pf is an important economic consideration.

To use it, simply clip voltage leads to potential source and clamp hook around conductor. Then rotate selector dial to get proper pf reading. Meter gives readings accurate to within 0.05 power factor. It has a frequency range of 50 to 90 cycles, an effective scale length of 13.5 inches.

General Electric Co, Schenectady 5, N. Y.

STEAM-TURBINE PUMP P760

Close-coupled, steam-turbine driven centrifugal pump is easy to install as it needs small space and no rigid foundation. It can be mounted at any angle—even on the wall. Close-coupled construction assures positive alignment. Being steam-turbine driven, pump's speed can be easily adjusted.

Standard models are used for water supply, air-conditioning, general liquid handling and for general-purpose applications in plants with steam power. They are also

today piping repairs *cost more!*

Crane No. 465½
Iron Body Gate Valve

You make fewer of them

by using Dependable Quality

CRANE VALVES

...That's why more Crane Valves are used than any other make

No bonnet joint trouble with this valve

A typical example of low-maintenance Crane Quality—No. 465½ 125-Pound Iron Body Gates. Rarely does the bonnet joint need attention. Flange construction includes reinforcement to prevent distortion and utilizes more bolts, more closely spaced, than is usual in valves of this class. Crane precision-guided seating reduces seat and disc wear. Packing has long life because these valves have a deep stuffing box filled with high grade asbestos ring packing. A ball-type gland helps to equalize the packing load.

Better performance features like these make Crane the better buy in valves of every type. Ask your Crane Representative for a demonstration of Crane better valves.

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General Offices:
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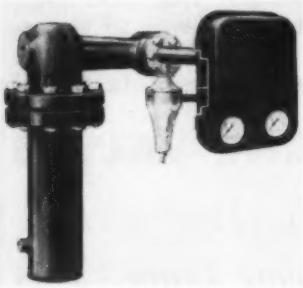
VALVES • FITTINGS • PIPE • PLUMBING • HEATING

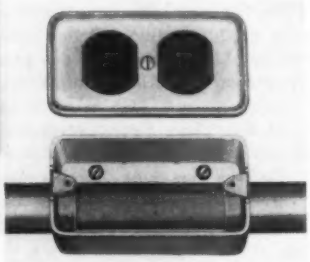
Begins on page 160

used for standby pumps for emergency in steam plants. They are built in 1¼- to 3-in. sizes, capacities to 600 gpm, and head to 320 ft. Available in special constructions with mechanical seals where temperature, pressure or chemicals are factors.
Byron Jackson Co, PO Box 2017, Terminal Annex, Los Angeles 54, Calif.



LIQUID-LEVEL CONTROL P755

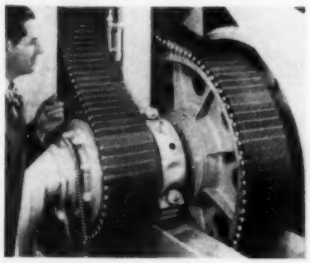
Torsion tube assembly transmits liquid-level changes and eliminates the need for objectionable packing glands and pressure-tight bearings. Type 888 displacement liquid-level controller is designed for external mounting on pressure vessels, kettles, receivers, separators and other devices where liquid-level control is needed.
Black, Sivalls & Bryson, Inc, 7500 E. 12th St, Kansas City 3, Mo.



FLOOR-DUCT OUTLET P712

Fitting housing (Catalog No. 761-B) is installed over raceway base without cutting the raceway. After installing housing and "laying-in" of conductors, capping of the two-piece floor-duct raceway is snapped into place and receptacle wired.
National Electric Products Corp, 13th Fl, Chamber of Commerce Bldg, Pittsburgh 19, Pa.

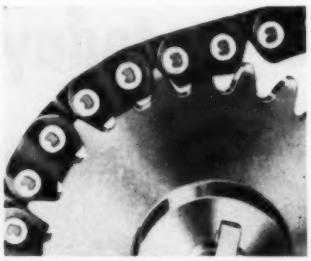
For more data on these items, use post cards, p169. Identify request with P and number.



CHAIN DRIVE P713

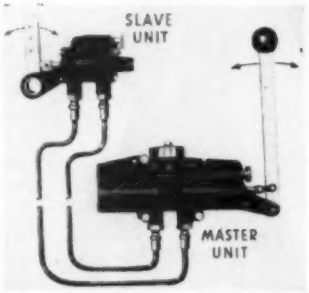
Hy-Vo (high velocity) chain drive can transmit to 5000 hp at linear speeds up to 6500 feet per minute or 3600 rpm. A 2-in.-wide *Hy-Vo* drive has transmitted 500 hp.

Besides increases in speeds with much narrower widths than conventional drives, *Hy-Vo* drives eliminate need for wide, unwieldy units with costly shaft extensions, outboard bearings, mounts and other accessories presently required for high-speed engines. According to Morse engineers, this drive can increase efficiency and reduce power-transmission costs in any field where single motors or engines are used in sizes 100 hp and up.



New chain-and-sprocket engagement principle virtually eliminates "chordal" or polygon action common to the usual chain drive (bumping, slapping, jerking action). Sprockets resemble involute gears, having curved teeth that engage the *Hy-Vo* links.

Hy-Vo does not replace present roller or silent-chain drives, but rather supplements them. It is designed specifically for speed applications higher than conventional chain drives, and to replace unwieldy belt drives now required for high-speed power transmission. A 6-in. *Hy-Vo* drive, for example, will do the work of a 24-in. belt.
Morse Chain Co, 7601 Central Ave, Detroit 8, Mich.



REMOTE CONTROL P747

A master unit interconnects through two small tubes with a slave unit of a hydraulic remote-control system to give positive load-carrying ability in both directions. Special provisions allow for expansion and contraction of both fluid and metal under temperature changes so synchronization between master and slave units is not upset. This control assembly can handle up to 500 in.-lb or torque.
Superdraulic Corp, 14256 Wyoming Ave, Detroit 4, Mich.

CATHODIC PROTECTION P717

A 3x60-in. graphite ground-anode for longer life: there are more pounds of graphite per unit of exposed surface. It is rugged enough to stand up under normal installation bumps without damage, is easy to transport to the field, easy to center in the backfill and easy to tamp.

These units are recommended for cathodic protection of pipelines, tank farms, refinery equipment, ships, electric substations and all sorts of underground and underwater metal structures. They are furnished complete with 36-in.-long insulated No. 8 weatherproof cable.
National Carbon Co, Div of Union Carbide and Carbon Corp, 30 E 42nd St, New York 17, N. Y.

THERMOCOUPLE WIRE P709

Two-conductor, 24-ga copper-constantan thermocouple wire suitable for refrigeration applications has moistureproof polyvinyl-chloride insulation. Over-all dimensions are about 3/64x3/32 in. Temperature range is from —20 F to 225 F. Where no flexing occurs lower limit is below —30 F. It has high moisture and abrasive resistance and has "safe" flexing within temperature limits.
Minneapolis-Honeywell Regulator Co, Brown Instruments Div, Wayne & Windrim Ave, Philadelphia 44, Pa.

CIRCUIT BREAKER P725

Low-voltage air circuit breaker, DB-50, with interrupting capacity of 50,000 amp. Switchable for use in low-voltage industrial and commercial power-distribution systems, central-station auxiliaries, motor-starting duty, etc.

DB-50 features a completely new air-delayed series over-current tripping device,

"Even *the* UNUSUAL can include *the* CONVENTIONAL"—REVERE

ATMOSPHERIC TOWER OVERHEAD CONDENSERS

Each battery of 6 has a total capacity of 60,000,000 BTU/hr with 18,000 square feet of effective surface. Made by Henry Vogt Machine Co., Louisville, Ky. Revere Naval Brass fixed end plates are 38½ in. diameter by 2⅛ in. thick, floating end plates are 35¾ in. diameter by 2 in.

These Henry Vogt Machine Co. condensers have an unusual feature: vapor belts in the shells to feed more copious and uniform flows of vapor than are obtained by the usual single nozzles.

Inside the condensers, the tubes are rolled into Revere Naval Brass Tube Sheets.

The use of Revere Naval Brass for this purpose is completely conventional in condenser building practice. Revere Naval Brass is corrosion resistant, strong, tough, durable. Every mechanic on the production line knows how to fabricate it. Every maintenance man knows how to treat it when doing a servicing job. Thousands of Revere Naval Brass plates are in daily use in condensers and other heat exchangers built by all the best manufacturers. Some of these plates have been in service for decades.

Revere has alloys for your unusual design features too. Some of these are conventional, made to do unusual jobs because the Revere Technical Advisory Service knows where and when to recommend them. Others are less well known.

When you work out an unusual design you want to concentrate your attention on the unusual features. Under those conditions, use the time tested, service proven, utterly dependable standard Revere alloys in the standard parts of your design and you will be able to forget those parts and keep your attention where it is needed.

For any problem at all that involves the use of metals, consult the Revere Technical Advisors. Their knowledge, skill, experience, contacts (yes, we ask questions as well as answer them) can add up to money in the bank for you.

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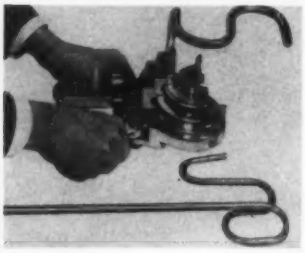
Begins on page 160

with all elements completely adjustable, that provides long-time delay on overloads and instantaneous tripping of fault currents. For use on feeder and back-up breakers, overcurrent trip units including both a long-time and short-time delay element can be specified, thus providing for selective operation on fault.

Rated at 600-v ac, 250-v dc, DB-50 has a continuous rating of 100 to 1600 amp. It can be operated manually, or by either dc solenoid or ac *Rectox* solenoid.

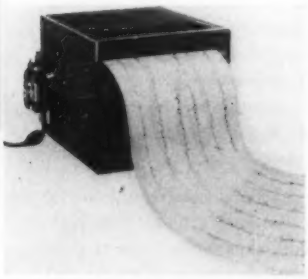
Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.



TUBE BENDER **P740**

Strong, lightweight, metal hand-tool makes it easy to get offsets and bends up to 180 deg in ⅜, ½ and ⅝ in. OD, with materials such as K and L copper tubing, brass, Bundyweld, steel and other light-gage tubing. All three sizes are combined in one tool so the 3-in-1, model 1200, has no loose parts.

Tal Bender, Inc, Milwaukee 2, Wis.

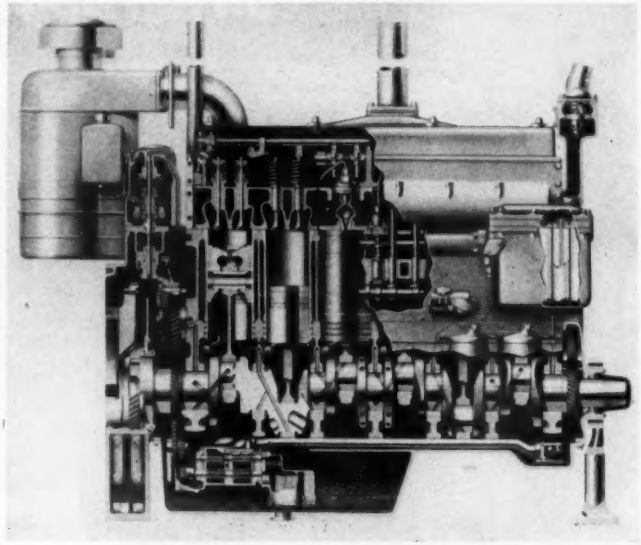


INDUSTRIAL RECORDER **P741**

Direct-writing, high-speed oscillograph, *Dynograph*, with microvolt dc sensitivity operates at about 100 times the usual speed of other industrial recorders with the same sensitivity. It has a pen deflection linearity of 1% with pen response of 1/120th of a second.

Offner Electronics Inc, 5320 N. Kedzie Ave, Chicago, Ill.

For more data on these items, use post cards, p169. Identify request with P and number.



INDUSTRIAL DIESELS WITH MANY NEW DESIGN FEATURES **P706**

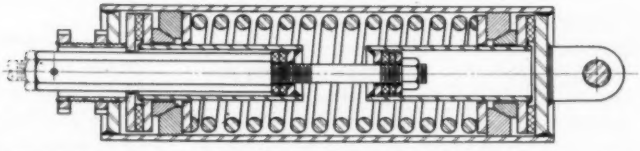
The 6-cyl D337 engine is an industrial version of the 5½x6-in. engine developed as a power source for the DW20 and DW21 tractors. The D326, though quite similar in design, is offered in a lower horsepower range. Horsepower ratings of each model, without fans, vary, depending on loading. The D337 is rated at 180 hp at 1600 rpm, but has peak output of 275 hp at 2000 rpm, intermittent-operation rating of 250 hp at 2000 rpm, and for continuous operation output is 170 hp at 1600 rpm. D326 unit is rated at 125 hp, has 186-hp peak rating, 171-hp intermittent and 118-hp continuous at same speeds as the D337.

A 25-hp vertical gasoline-starting engine is used. It has been completely redesigned for easier starting regardless of weather.

Oil-cooled pistons on these diesels have an iron band cast integrally for the upper ring, are cooled by an oil stream sprayed from a nozzle solidly attached to the engine block. Since spray lubricates piston pin, as well as cooling the piston, oil grooves aren't needed in connecting rod.

Other design features include standard, identical fuel lines for each cylinder and fine filtration elements that handle full flow of oil to engine system.

Caterpillar Tractor Co, Peoria 8, Ill.



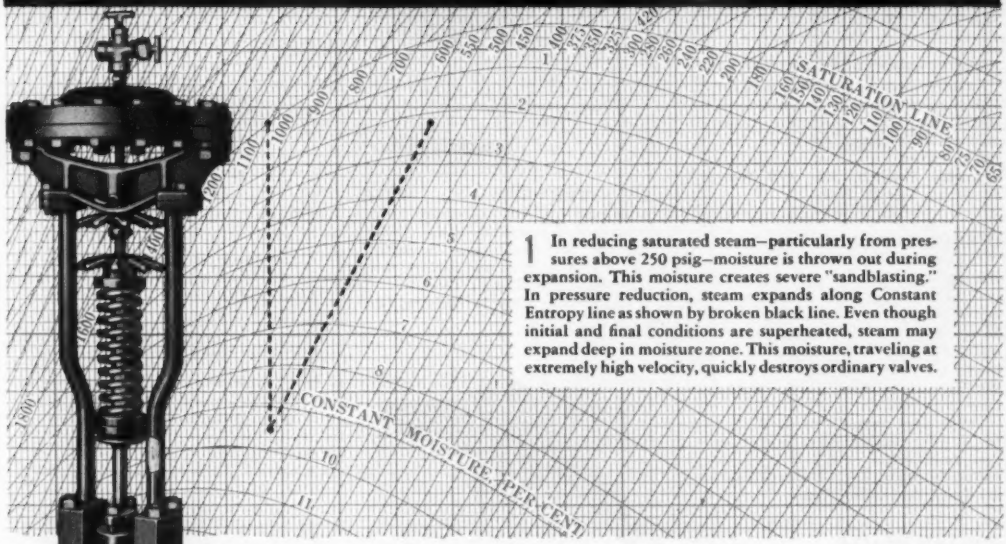
NONRESONANT SWAY BRACES HAVE SINGLE SPRING **P707**

This sway brace comprises a single compression-type spring, confined between two movable piston plates enclosed in a welded tubular housing. Spring is precompressed so any tendency of pipe to move in either direction is resisted by a force equal to the initial loading of the sway brace. Normally no stress is exerted on the piping but if the pipe sways or vibrates, the restoring force increases as a direct function of the movement.

Energy absorption, to help further in damping vibration, is accomplished through use of cast-iron shoes, which are forced outward against housing wall, imposing a large frictional hysteresis on the system when movement of either piston plate occurs.

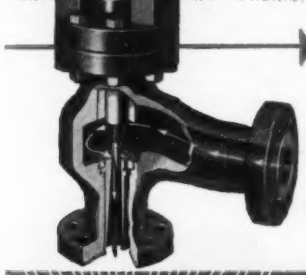
NR sway brace comes in nine sizes giving an initial-loading range of 92 to 1500 lb and a maximum restoring-force range, at full deflection, of 207 to 2250 lb. Initial

Swartwout V-10 Flow Regulating Valves slash maintenance costs in systems with high pressure drop or flashing condensate



1 In reducing saturated steam—particularly from pressures above 250 psig—moisture is thrown out during expansion. This moisture creates severe "sandblasting." In pressure reduction, steam expands along Constant Entropy line as shown by broken black line. Even though initial and final conditions are superheated, steam may expand deep in moisture zone. This moisture, traveling at extremely high velocity, quickly destroys ordinary valves.

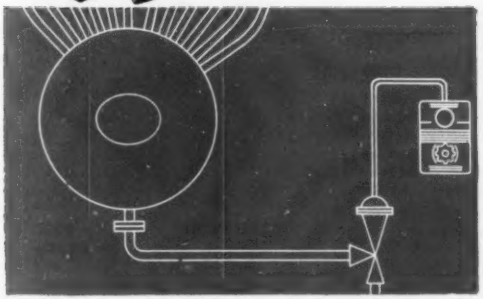
Chart from *Thermodynamic Properties of Steam* by Keenan & Keyes. Reproduced by permission of John Wiley & Sons, Inc., Publishers



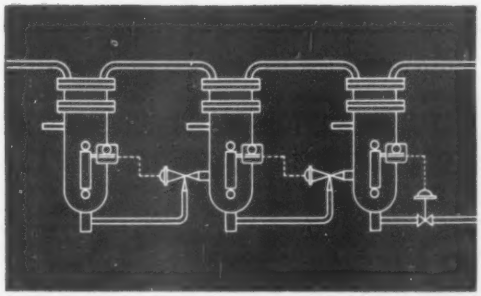
2 Swartwout V-10 valves are scientifically designed to handle liquids at high pressure drops and also under *flashing conditions.* All direct impingement is eliminated and longer valve life is assured two ways—by better flow design, plus use of materials specifically selected for the service involved. As a result, *Swartwout V-10 valves outperform other valves in similar service.*

Swartwout

POWER PLANT EQUIPMENT



3 High pressure boiler blowdown service is extremely rigorous. When closed, there is full pressure drop across valve; when open, high velocities and flashing rapidly increase line loss and decrease the allowable drop across the valve. The variations in pressure make this service critical since valve must handle all conditions.



4 In saturated liquid drainage service, such as on high pressure extraction type heaters, water at saturation temperature flashes into steam when pressure is reduced. Exclusive scroll inlet and gradually expanded straight outlet of V-10 valve design permit a sliding action instead of direct impingement thus preventing corrosion-erosion. A-4208

SEND FOR BULLETIN S-208A • THE SWARTWOUT COMPANY, 18511 EUCLID AVENUE, CLEVELAND 12, OHIO

More EQUIPMENT NEWS

Begins on page 160

precompression of spring, which is 2 in. for all sizes, can be increased an additional inch, varying the initial load.
Bergen Genspring Corp, 15 Park Row, New York 7, N. Y.

HIGH-TEMPERATURE GREASE P716

Kantmelt grease does not melt under high temperatures. It is a synthetic grease, suitable for ceramic production, foundries, smelting and refining operations, ferrous and nonferrous metal treating and refining.
Specialty Products Co, 190 Warren St, Jersey City 2, N. J.

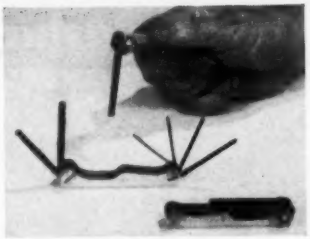
TEMPERATURE REGULATOR P733

Self-powered temperature regulator, No. 999, has press-formed frame of stainless steel to cut down heat conduction from the valve to the regulator head. This gives better control with less weight plus a reduction in over-all dimensions. An extra-large 2-ply metal Sylphon bellows in the thermal unit provides added power for valve operation.

Temperature ranges start at 40 F and end at 440. Available in valve sizes ½ to 4 in., inclusive.
Fulton-Sylphon Div, Robertshaw-Fulton Corp, Knoxville, Tenn.

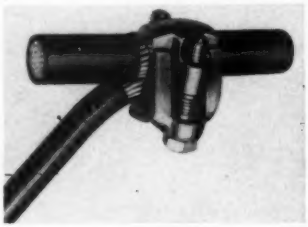
TUBULAR HEATER P736

Previous problems in electric heating, such as carbonization and other forms of fluid breakdown resulting from local overheating, are avoided, says the manufacturer, with its complete line of tubular heaters. This line provides a low-density electric heat for oils, tar, resins, and other viscous fluids. Heaters are installed without liquid joints, and internal heating element can be removed from tube enclosures at any time without draining fluid from the vessel.
Hynes Div, Martin-Quaid Co, 1893 Sedgley Ave, Philadelphia 32, Pa.



SOCKET WRENCHES P744

Single-hand tool fits smaller-size standard socket head screws and bolts. *Smitty Jr* has six individual socket wrenches, .05, 1/16, 5/64, 3/32, ⅛ and 5/32 in. that fold knifelike into a single handle.
H D Hunter Co, 3499 E. 14th St, Los Angeles 33, Calif.



ELECTRICAL CONNECTOR P727

Body and cap are serrated to prevent cables from working loose after tap is installed. Conductors are forced into high-pressure contact by two standard hex head cap screws. Spacer is available if desired for separating individual conductors. Sizes from No. 3 to 1000 Mcm (main); No. 10 to 1000 Mcm (tap).
O Z Electric Mfg Co, 362 Bond St, Brooklyn, N. Y.

Now Take Another Minute To Check These . . .

Hand-Hole Gaskets for steam, air, water, ammonia etc. ..... p 176

Laundry-Washer Control handles four reversals per minute with dwell period ..... p 176

Indicator, refrigerating liquid level p 178

Split-Core Ammeter having a split-plug appliance attachment. Instrument suitable for current measurements on ¼-hp or less ..... p 178

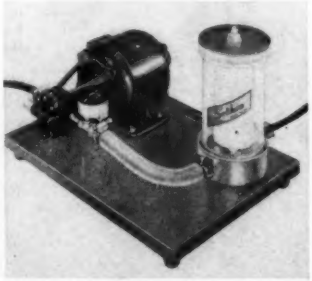
Transformer Unit with series of improvements ..... p 180

Oil Conditioner for small batch clarification of used hydraulic, lubricating, run-in and transformer oils ..... p 182

Glass Filter replaceable element ..... p 184

ELECTRIC HAMMER P737

Long-life electro-mechanical hammer has a special spring assembly that permits the *Kango* hammer pressure to bounce harmlessly between two springs whenever the hammer is withdrawn from work. This transmits only a slight tremor to the hammer body itself. The effect of the blows on the hammer body when the job is finished shortens the life of the usual electro-mechanical hammer. Line consists of three sizes: heavy-, medium- and light-duty, plus a large variety of special tools to suit many jobs. Heavy-duty hammer is 22 in. long, weighs 21 lb, and strikes 1300 blows per min.
Allied Tools, Inc, 321 Central Ave, Newark 4, N. J.



OIL FILTER-PUMP P730

Model LGI-5 is designed for filtering light oils, fuel oil, glycerine, glycol and other organic lubricating liquids. It may be mounted above the liquid level in the supply tanks and will operate without manual priming.

This power-operated filter is equipped with a compact, positive pressure, self-priming spur gear pump. Pump consists of an aluminum body and two hardened-steel spur gears. It is equipped with a spring-

(*Continued on page* 176)

SOUND-RATING FOR FLUORESCENT LIGHTING BALLASTS P720

System of sound-rating fluorescent-lamp ballasts to improve installations of fluorescent lighting systems. Based on a scientific measurement of the average sound levels produced by certain ballast designs, the new rating groups GE ballasts in six classifications, ranging from A, extremely quiet, to F, quite audible.

Use of these classifications, along with consideration of other noise-contributing factors, such as ambient sound levels in different types of rooms, will result in the most satisfactory fluorescent-lighting installations. For example, if fluorescent lighting is desired in extremely quiet locations—as churches or broadcasting studios—only lamps that can be powered by A-rated ballasts should be considered for normal installations. In applications where higher ambient noise levels are prevalent, lamps using ballasts rated as B, C, D, E or F may be employed, depending on location's "tolerance" for increased noise.

All fluorescent ballasts, regardless of manufacturer, produce some audible hum. But the prominence or disturbing effect of the sound can be controlled to an appreciable extent by considering the following factors: (1) nature of the ballast-produced sound—its intensity, duration, and component frequency (2) construction and mounting of the fixture (3) ambient noise level of the room (4) acoustical properties of the room (5) number of fixtures installed and (6) listener reaction.
General Electric Co, Schenectady, N. Y.

For more data on these items, use post cards, p169. Identify request with P and number.

WELDOLETS

WELDING FITTINGS FOR ANY PIPING SERVICE

NATURAL GAS COMPRESSOR STATION PIPING CONSTRUCTED ECONOMICALLY AND EFFICIENTLY USING WELDOLET WELDING FITTINGS THROUGHOUT

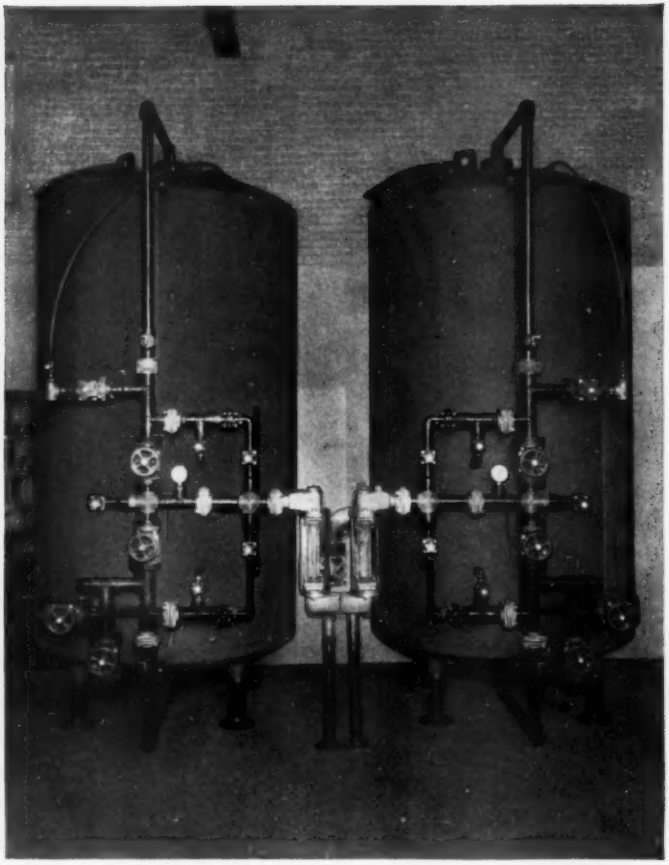
This installation, together with a number of important applications of WeldOlet Welding Fittings in various types of service is shown in the new Bonney W-3 WeldOlet Catalog.

The completely new Bonney catalog will furnish descriptions, dimensional information and installation instructions. The technical section demonstrates graphically how WeldOlet Welding Fittings offer the quickest, safest and most economical method of establishing and maintaining 100% pipe strength at branch connections in accordance with code provisions.

Write for your free copy to: **BONNEY FORGE & TOOL WORKS** 380 Green St., Allentown, Pa.

Export Distributor: NATIONAL SUPPLY EXPORT CORP., 60 Fifth Ave., New York 20, N. Y.

Silica < 0.01 ppm



DUPLEX MIXED-BED de-ionizing unit for Eastern public utility company, photographed during fabrication in the Illco-Way shop. Unit is designed to produce a water of the highest chemical purity including complete silica and CO_2 removal and with a composite resistance of 8,500,000 ohms per cm^3.

▶ SINCE THE FIRST Mixed-Bed De-ionizing unit* was introduced to the industry by the Illinois Water Treatment Co. in 1949, this method for purification has rapidly gained acceptance.

At the present time, according to ILLCO-WAY records, more than 2,500,000 pounds per hour, with silica content of less than 0.01 parts per million, are being produced by ILLCO-WAY Mixed-Bed* equipment.

With feedwater containing less than 0.1 parts per million ionizable solids, and with a composite resistance of 8,500,000 phms per cm^3, boiler and turbine maintenance is greatly reduced and operating efficiencies are improved.

Purity is constant regardless of load variations. ILLCO-WAY Mixed-Bed units are designed for either manual or automatic operation, and can be operated on raw water supplies or added as a final treatment to present conditioning equipment. Complete literature on de-ionizing can be secured by writing to ILLCO-WAY.

**Process and equipment patents pending.*

Analysis of Feedwater (Parts per million as $CaCO_3$)

(Analysis made by an independent laboratory of a feedwater produced by Illco-Way Duplex Mixed-Bed system)

Ca - 0	HCO_3 - 0.05	CO_2 - 0.04
Mg - 0	SO_4 - 0	SiO_2 - 0.01
Na - 0.05	Cl - 0	pH - 6.80

ILLCO-WAY

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DE-ALKALIZING
SOFTENING

See data in Sweet's File, Engineering

ionXchange

ILLINOIS WATER TREATMENT CO., 853-7 Cedar St., Rockford, Illinois • 141 East 44th Street, New York City

Canadian Distributor: Pumps & Softeners Ltd., London, Ontario

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B1 **PULVERIZERS** — Illustrates and describes Jeffrey swing hammer pulverizers and crushers made in two types—Type A for general purposes, and Type B for finer reduction, breakdown and heavier work. 36-page catalog No. 837. Jeffery Mfg Co, 932 N 4th St, Columbus 16, Ohio.

B2 **DUST COLLECTION**—Covers the American Blower Series 342 precipitator for fly ash, cinders, and industrial dusts. Selection data, performance factors, assembly arrangements, dimensions and physical data included. 12-page bulletin No. 1728. American Blower Corp, Detroit 32, Mich.

B3 **WALLS AND ARCHES** — Gives description of Laclede suspended arches and sectionally supported walls and their application to all types of furnace enclosures. Technical data included. 32-page catalog No. 4. Laclede-Christy Co, 3600 Forbes St, Pittsburgh 13, Pa.

B4 **OIL PREHEATER** — Discusses Hauck electric oil heaters with automatic control of oil temperatures for heating heavy grades of fuel oil. 4-page folder No. 709. Hauck Mfg Co, 124-136 10th St, Brooklyn 15, N. Y.

B5 **PACKAGED STEAM GENERATORS**—Two bulletins on steam generators available. 8-page catalog No. 51 covers Cyclotherm package steam generators. 6-page bulletin No. P-1 gives data on automatic steam generators. Cyclotherm Corp, Oswego, N. Y.

B6 **REFRACTORIES**—Shows where, when and how to use refractory and insulating materials of various types in industrial heat processing and heat generating equipment of all kinds. 40-page catalog. Refractory & Insulation Corp, 120 Wall St, New York 5, N. Y.

B7 **OIL BURNER** — Describes the Peabody wide-range constant differential pump system for use on oil combustion installations. Chart given establishes that oil-air ratios affect combustion efficiency under varying loads. 4-page bulletin No. 109-B. Peabody Engrg Corp, 580 5th Ave, New York 19, N. Y.

CONTROLS, ELECTRIC

B8 **STRIP CHART RECORDER**—Explains how up to 6 permanent

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records of industrial processes may be obtained on the new Multipoint Capacilog strip chart recorder. Complete specifications and listing of models are included. 4-page bulletin No. MPC-1. Wheelco Instruments Co, 847 W Harrison St, Chicago 7, Ill.

★ **MOTOR CONTROLS** — Condensed information, dimensions and prices of the more popular items in the Allen-Bradley line of motor controls. A special a-c and d-c index is included along the margins of each page. 92-page catalog. Allen-Bradley Co, 118 W Greenfield Ave. Milwaukee 4, Wis. (• Write direct to manufacturer on company stationery giving name and title.)

B9 **MULTI-CIRCUIT TIMER**—Details on a multiple circuit cycle timer for timing laundry and dry cleaning machinery operations, electrical display signs, industrial furnaces. Bulletin No. 142. Zenith Electric Co, 152 W Walton St, Chicago 10, Ill.

B10 **PHOTOELECTRIC ALARM**—Data on a photoelectric intrusion alarm set P1A which provides a protecting wall of invisible light across any space up to 50 ft. Bulletin No. PI-511. Photoswitch, Inc, 77 Broadway, Cambridge 42, Mass.

ELECTRICAL EQUIPMENT

B11 **INDUSTRIAL LIGHTING**—Aimed at the industrial plant operator, booklet analyzes fluorescent, mercury vapor, and incandescent lighting as to type of light, efficiency, lamp life, etc. Special lighting for special areas illustrated. 16-page booklet No. B-4727. Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

B12 **FLUORESCENT LAMPS** — Describes Slimline fluorescent lamps including such details of construction as the triple-coil cathode, the shielded cathode, the treated exhaust tube and aluminum bases. 12-page booklet No. 1b-192. General Electric Co, Lamp News Bureau, Nela Park, Cleveland 12, Ohio.

B13 **MOTORS**—Illustrations and data given on Wagner single-phase and polyphase motors. 4-page folder No. MU-94. Wagner Electric Corp, 6400 Plymouth Ave, St. Louis 14, Mo.

B14 **INSTRUMENT TRANSFORMERS** —Buying information on G-E indoor and outdoor potential transformers, current transformers, metering outfits, potential and current portable transformers. 94-page bulletin No. GEA-4626. General Electric Co, Schenectady 5, N. Y.

B15 **CIRCUIT BRAKER** — Details on the new DB-50 low voltage air circuit breaker for application in low-voltage industrial and commercial power distribution systems and similar uses. 8-page booklet No. B-4740. Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

INSULATION, HEAT, COLD AND VIBRATION

B16 **HIGH TEMPERATURE INSULATION** — Gives advantages and properties of Superex block insulation, backed up with conductivity and heat loss graphs as well as a recommended thickness table. Also shows shapes in which Superex can be furnished. 4-page folder. Johns-Manville, 22 E 40th St, New York 16, N. Y.

B17 **PERIMETER INSULATION** — Booklet, "The Story of Perimeter Insulation for Standard Heating Systems," serves as a guide to a better understanding of the nature, proper use and application of perimeter insulation. 20 pages. Owens-Corning Fiberglas Corp, Dept PI, Toledo 1, Ohio.

B18 **UNDERGROUND CONDUIT**—Describes Therm-O-Tile underground pipe conduit, a complete conduit system for the permanent protection, support, and insulation of underground pipe lines, hot or cold. Sizes and specifications given. 8-page bulletin No. 511. H W Porter & Co, Inc, —Reid Hayden, Inc, 825 Frelinghuysen Ave. Newark 5, N. J.

MAINTENANCE AND SAFETY EQUIPMENT

B19 **FIRE EXTINGUISHERS**—Folder covers complete line of portable and special-purpose fire extinguishers. Chart provides guide for selecting the right extinguisher for every type of fire hazard in industry, institutions and the transportation field. Stop-Fire, Inc, 125 Ashland Place, Brooklyn, New York.

B20 **CLEANING SERVICE**—Describes how Dowell service provides an efficient means of cleaning steam generators, heat exchange equipment and water lines—and for increasing water well output. 6-page bulletin. Dowell Incorporated, Dept P, P O Box 536, Tulsa 3, Okla.

B21 **RETAINING RINGS** — Engineering specifications and data on a series of external type retaining rings applied radially without pliers. 8-page bulletin No. 7. Waldes Kohinoor, Inc, Truarc Catalog Service, 47-16 Austel Place, Long Island City 1, N. Y.

B22 **OIL RECLAIMER**—Data on Hilco oil reclaimers for diesel and gas engines. Performs continuously or intermittently direct-connected to the engine, or as a batch reclaimer. 4-page bulletin No. R-238. Hilliard Corp, 102 W 4th St, Elmira, N. Y.

B23 **PIPE TOOLS** — An operating guide to help users secure the best possible results from portable pipe and bolt machines and hand pipe tools. Thirty-one different operations are covered. Beaver Pipe Tools, Inc, 334 Dana Ave, Warren, Ohio.

B24 **THREAD INSERTS**—Covers design data on helical-wire thread inserts and the use of these inserts in the protection and repair of tapped holes. 16-page bulletin No. 650-R. Heli-Coil Corp, 47-23 35th St, Long Island City 1, N. Y.

B25 **TRAMP IRON REMOVAL** — Describes non-electric permanent magnetic separators for tramp iron removal. Includes engineering data, selection information, factory engineering service available, etc. 16-page catalog No. 15. Eries Mfg Co, Erie, Pa.

MAINTENANCE MATERIALS

B26 **PACKING RINGS** — Features 5 types of Vee-Flex packing rings for use in valves, pumps, hydraulic cylinders, rams, presses, and lifts against a long list of services and pressures. 4-page bulletin. Raybestos-Manhattan, Inc, Packing Div, Manheim, Pa.

B27 **ELECTRICAL TAPE**—Discusses how electrical tape No. 22 combats the corrosive action of moisture, alkalies, oils, fats, and fungi on underground gas service pipes. 4-page brochure. Minnesota Mining & Mfg Co, 900 Fauquier St, St. Paul 6, Minn.

B28 **HOSE CLAMPS AND FITTINGS** —Illustrates and describes the Punch-Lok clamping method and its applications. Lists the standard clamps, locking tools, and special fittings available. 12-page catalog No. 300. Punch-Lok Co, 321 N Justine St, Chicago 7, Ill.

B29 **BOILER PROTECTION** — How to save fuel tanks, boilers and piping in hot water and steam systems

(*Continued on page* 214)

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My Name .....

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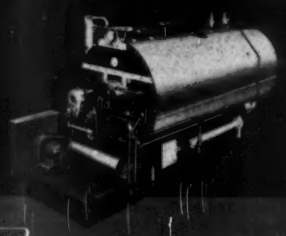
HERE'S PROOF!

Boiler rooms are
QUIETER, CLEANER, SAFER, with
SUPERIOR'S Built-in, INDUCED Draft.

Superior's Induced Draft prevents the escape of combustion gases into the boiler room . . . even through an open port. For our photo shows one of our engineers observing the fire through the wide open pressure-relief port.

It also explains one other distinct advantage of induced draft . . . the fact that the fire is pulled through each successive pass without impingement and wear on refractory as is the case under forced draft. For that relief port is at the end of the first pass where the combustion gases are turning the corner into the second pass. If they weren't being led, some of them would find their way out through the open port.

Greater quiet; longer trouble-free operation; cleaner, more healthful atmospheres are other primary results. We can't tell you the whole story here, but you'll find it all in our new catalog. Write today to reserve your copy of the newest edition. Ask for Catalog 301.



SUPERIOR
STEAM GENERATORS

SUPERIOR COMBUSTION INDUSTRIES, INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 18, N. Y.

BOOKSHELF

SELECTED FOR YOU IN THIS ISSUE:

PLANT LAYOUT PLANNING AND PRACTICE
CODE FOR PRESSURE PIPING, ASA
FUNDAMENTALS: ELECTRICAL ENGRG
ELECTRONIC MOTOR, WELDER CONTROLS
MALLEABLE IRON SCREWED FITTINGS, ASA
HOW TO RUN A LATHE
HANDBOOK OF POWER RESISTORS
SYNCHRONOUS MACHINES
AIR-POLLUTION PROCEEDINGS
THERMODYNAMICS
BASIC THERMODYNAMICS
BOILER-WATER TREATMENT MANUAL

FEATURED THIS MONTH

OPERATION OF ELECTRONIC EQUIPMENT EXPLAINED

ELECTRONIC MOTOR AND WELDER CONTROLS (*1st edition*, 1951). *By George M Chute, application engineer, General Electric Co*, 348 *pp*, 6x9 *in.*, 196 *illust, cloth*. $6.50. *McGraw-Hill Book Co*, 330 *W* 42nd *St, New York* 18, *N. Y.*

Probably too many books have been written on electronic-circuit theory and components of circuits and too few that explain how commercial electronic equipment operates. The author does much to correct this lack, and shows what makes a lot of the controls click, and how.

Electronic-tube equipments are used extensively in industrial plants. Of these, two important groups are controls for resistance-welding machines and electronic speed controls for dc motors driving machine tools and industrial processes. Many plants use these tube-operated equipments.

First part of the book describes many resistance-welding controls developed since 1934. This section may be considered an extension of the author's book, *Electronic Control of Resistance Welding* (1943). Second half deals with several types of electronic controls for dc motors supplied from ac circuits. While some of the general-purpose electronic motor controls were covered in the author's *Electronics in Industry* (1946), in this book he presents improved electrical circuits with a much greater variety of closed-cycle motor-control systems.

Here is practical assistance for the man who must select, install and service electronic controls for resistance welders and motors. From the descriptions and diagrams he gets a full understanding of circuit operation in the two classes of equipment.

Air-Pollution Proceedings

PROCEEDINGS, 43RD ANNUAL MEETING, AIR POLLUTION AND SMOKE PREVENTION ASSN OF AMERICA. 8½x11, 122 *pp, paper*, $5. *John Paul Taylor, publisher, St Joseph, Mich.*

All the papers presented at the 1950 meeting of the Air Pollution and Smoke Prevention Assn are assembled in this book. They total 25 in number and range from railroad problems to industrial and domestic. Incinerators, dust collectors, stack disposal feature some of the more technical papers.

Several others discuss the public relations side and the practical difficulties the operating man finds in living with air-pollution ordinances.

Thermodynamics

THERMODYNAMICS (*Second edition*—1951). *By G A Hawkins, professor of thermodynamics, Purdue University*. 563 *pp, illust, tables*, 6x8¾, $6.50. *John Wiley & Sons, Inc*, 440 *Fourth Ave, New York* 16, *N.Y.*

This book serves as a text for complete courses in engineering thermodynamics for engineering students. The author devotes some space to the kinetic molecular theory to build a firm foundation for the concept of internal energy. While much of the theory is based on the ideal gas laws, real gas laws are discussed to show the limitations of the simpler ideal concepts. The entropy concept to evaluate available and unavailable energy is investigated and demonstrated. Temperature-entropy diagrams are compared with companion pressure-volume diagrams for the various applications.

Chapter headings include: fundamental concepts, first law, solids, liquids, gases, ideal or perfect gas, equations of state for real gases, specific heat of gases, vapor tables, reversible non-flow processes, entropy, second law, carnot cycle, mixtures of ideal gas and vapors, combustion, nozzles and orifices, internal-combustion engines, air compressors and engines, gas turbines and jet propulsion, vapor cycles, mechanical refrigeration, general thermodynamic equations, heat transfer.

Plant Layout

PLANT LAYOUT PLANNING AND PRACTICE. *R W Mallick, executive staff engr, Westinghouse Electric Corp, and A T Gaudreau, management consultant, Gaudreau, Rimbach and Assoc*. 391 *pp, illus, tables*, 6½x10, *cloth*, $7.50. *John Wiley & Sons, Inc*, 440 *Fourth Ave, New York* 16, *N.Y.*

This is a practical book packed with material culled from years of actual experience. Written with the administrative executive and plant engineer in mind, it is a handy guide for senior and junior engineers, and for students, too.

Text is divided into four parts: approach to plant layout, planning processing departments, designing plant service facilities, and justifying the layout project. Of special interest to power engineers are chapters on sprinkler, power and lighting systems. There are many other good presentations of materials handling methods, routing, internal transportation, maintenance facilities, employe-service facilities and selection of building type.

Plant designers will get most from this book, but power engineers who must meet and solve problems of plant layout can learn much from the many drawings, photos and examples.

Electrical Engineering

FUNDAMENTALS OF ELECTRICAL ENGINEERING. *By Fred H Pumphrey, head, dept of electrical engineering, University of Florida*. 668 *pp*, 6x9-*in*. $7.65. *Published by Prentice-Hall Inc*, 70 *Fifth Ave, New York* 11, *N.Y.*

Although this is a text for students specializing in fields other than electrical engineering it serves well in the power engineer's library. In addition to the rotating machinery and electrical equipment generally found in the power plant, the author covers additional topics that do much to round out the picture. For instance, there is information on nonlinear resistors, permanent magnets, stabilized amplifiers, and electronic instruments.

Due emphasis is placed on electronics as connected with instrumentation and control. In addition to the explanation of the physical phenomena, sufficient information is included so simple amplifiers and electronic switches can be designed.

In addition to the descriptive treatment of electric motors the author devotes space to the all-important question of motor application. Here the problem of matching motor characteristics with those of the load are discussed at length.

Synchronous Machines

SYNCHRONOUS MACHINES: THEORY AND PERFORMANCE. *By Charles Concordia, analytical engineering dept, General Electric Co, Schenectady*. 224 *pp*, 6x9, $5.50. *John Wiley and Sons Inc*, 440 *Fourth Ave, New York* 16, *N.Y.*

This book is for those engineers directly concerned with the prediction of machine performance. The author develops the fundamental circuit theory of the transient performance of synchronous machines. Then

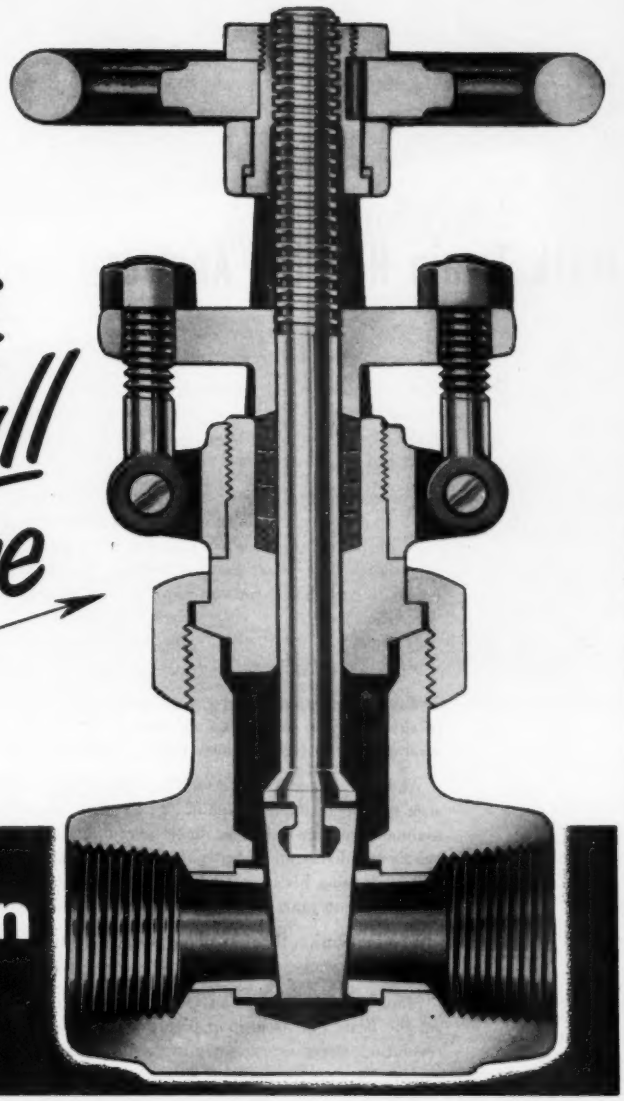
(*Continued on page* 188)

You can

Repack Under Full Pressure

with a

Chapman List 960



No pressure is transmitted to the stuffing box of a Chapman List 960 when the valve is in the open position . . . you can always repack it easily, fast, without stopping the flow through the valve. What's more, it's a tougher — more rugged — valve that reduces many other maintenance problems.

Take for instance, the wedge faces — they're hardened to 800 Brinell by the exclusive Malcomizing process to give peak wear resistance. Seat rings, too, have unusual wear-resisting and non-galling characteristics. And, in addition, recent design changes have resulted in stem and wedge gate connections 50% stronger than before.

Write *today* for detailed technical information. The Chapman List 960 is available in sizes from ¼" to 2", either metal to metal or gasketed joint. Rising stem with yoke (as illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. For higher pressures specify List 990.

The Chapman Valve Manufacturing Company

INDIAN ORCHARD, MASSACHUSETTS

Mark Twain Had the Answer

You remember a few months back I promised you an immortal essay on spring cleaning. Well this piece isn't quite what I had in mind at the time, because what I'm going to say wasn't really my idea. Mark Twain, for one, said it in his beloved book "Tom Sawyer."

You remember the time when Tom was faced with the job of whitewashing his aunt's fence when he would much rather have gone fishing. And you remember how despite this, Tom put on a convincing show of enjoying himself with the result that his friends, who had wandered by to mock, began to feel that there was some special privilege in whitewashing the fence. So those friends soon joined Tom in his labor (and Tom in a typically American way made a tidy profit by selling the privilege of whitewashing his aunt's fence).

That "Tom Sawyer" spirit is still around today. You know what happens in any American town when one man in the block paints his house; pretty soon everybody else gets busy until it looks like a new street.

And that same "Tom Sawyer" spirit can do wonders in the plant. I've seen it happen time and again. . . . I've seen sloppy plants with slouching maintenance crews change almost overnight just because one man would calmly but deliberately start putting his cigarette butts in the proper receptacles, cleaning his tools whenever he was finished using them and in his spare moments start touching up little paint jobs here and there.

You know what they say about hogs, they aren't naturally dirty . . . it's just the way we keep them. The same thing goes for people.

Sloppy maintenance is an insidious, contagious disease that can slowly eat the heart out of a good plant. But good maintenance can be like a revolution, sweeping everyone in the plant along with the spirit.

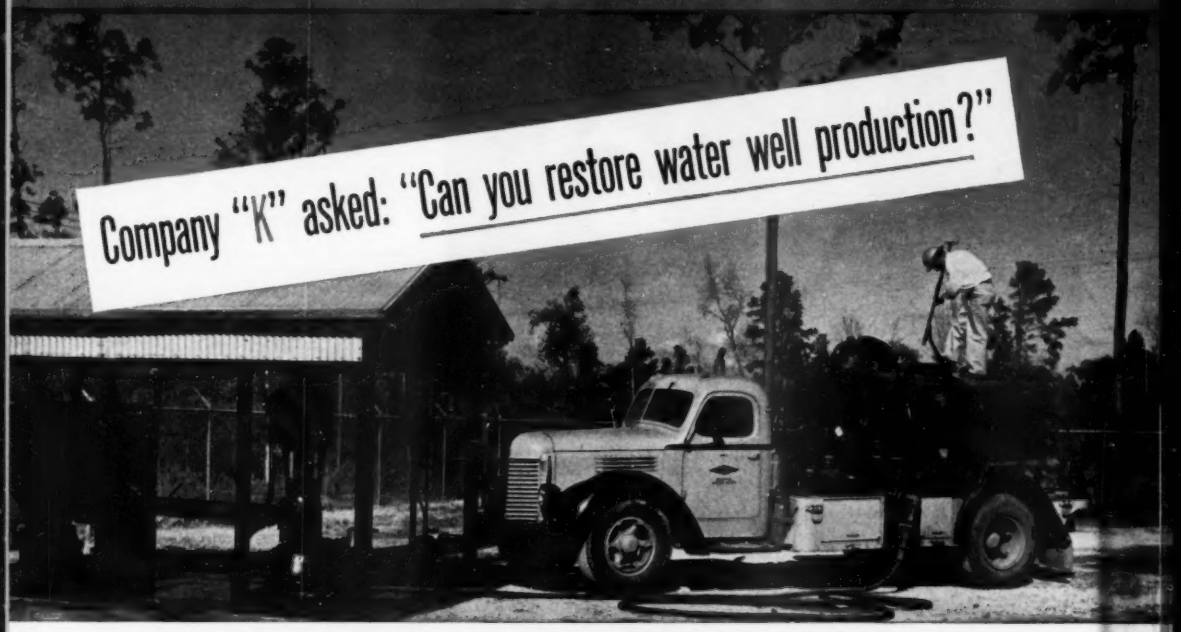
All it takes is one man, courageous enough to make an example of himself by doing instead of talking. And come to think of it, that same spirit might help a lot more of the world's problems . . . because every movement, good or bad, has started with just one man. And that man can be the lowest man in the plant. Lincoln was once a grocery clerk, and Jesus Christ a carpenter.

George Edwards

Engineer

DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS



Dowell Service increased water output 100%!

Water wells need cleaning, too. This company has a 33-year-old well in which volume had been cut by scale incrustation and corrosion deposits on the well screen, pump, tubing and on the face of the producing formation itself. Dowell Service quickly removed these deposits in a few hours without removing the pump and column. Water production was increased from 64 to 135 g.p.m. with a drawdown decrease of 27 feet.

Dowell Service may be the answer to your cleaning problem. Profit-stealing deposits in steam generators, condensers, gas washers, water lines . . . in hundreds of different types of process equipment . . . can be removed *chemically*. Dowell engineers fill the equipment with liquid solvents that flow wherever steam and water go and are designed to remove the deposits in a few hours without dismantling.

If you have a cleaning problem . . . a place where deposits are causing a maintenance headache . . . call Dowell. Skilled cleaning engineers are available for consultation at no obligation.

Other recent Dowell jobs:

Bubble Cap Columns **cleaned for large refinery. Cleaning so successful that maintenance engineers plan to make Dowell Service an annual job.**

Two Blast Furnace Gas Scrubbers **cleaned in 8 hours. 48 hours apiece required when cleaned mechanically.**

A 3,000 Horse-Power Stirling-type boiler **and economizer were both cleaned in a single operation requiring only 24 hours.**

CALL

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

New York 20	Buffalo 2	Kansas City 8	Mt. Pleasant, Mich.
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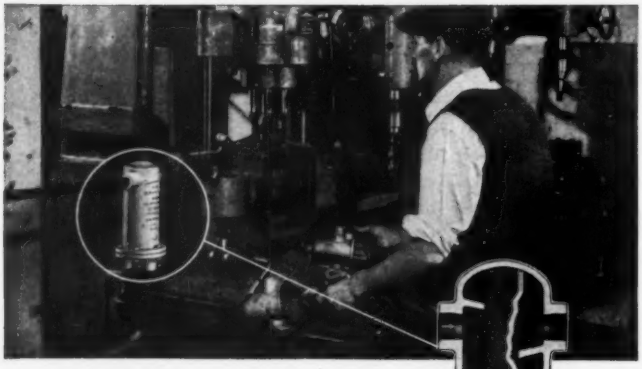
Baltimore 18	Detroit 2	Houston 2	Salem, Illinois
Wilmington 99	Chicago 2	New Orleans 12	Borger, Texas
Richmond 19	St. Louis 8	Ft. Worth 2	Midland, Texas
Jacksonville	Indianapolis	Shreveport 69	Wichita Falls, Texas
Atlanta	Louisville	Anniston, Alabama	Lafayette, La.

Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

A SERVICE ORGANIZATION

Need DRY AIR?



Get *positive* protection with Strong's Combination Separator and Trap!

Spray guns, air chucks, fixtures and other air-using equipment, *must* be kept free of water and oil for best results. Strong's Combination Separator and Trap will completely separate all liquids from air (or steam) and automatically discharge them.

CHECK THESE FEATURES:

★ Highest operating efficiency;
★ No cleaning required;
★ Copper-clad steel float (stainless steel at additional cost);
★ Anum-Metl seat and disc—guaranteed leakproof for one year;
★ Sizes from ½ to 1½ inches, screwed; pressures to 250 psi.

Other products in the *complete* STRONG Steam Specialties line include steam traps, strainers, separators, pressure regulators and continuous blow-down valves. For complete information, write for your copy of our new Catalog 68-P today, or see one of our over 200 distributors.

STRONG, CARLISLE & HAMMOND COMPANY

1392 West 3rd Street
Cleveland 13, Ohio

ANUM-METL Reg. Trade Mark

More EQUIPMENT NEWS

Begins on page 160

loaded bypass valve, set to bypass the liquid back to pump when pressure reaches 40 psi.

Filter cylinder assembly consists of transparent high-temperature lucite with stainless-steel fittings. Clear visibility of the lucite allows full observation of entire filtration operation. Filter cylinder holds less than 1 pint of fluid, all completely recoverable.

Sethco, 105-07 150 St, Jamaica 4, N.Y.

For more data on these items, use post cards, p169. Identify request with P and number

HAND-HOLE GASKETS P738

Designed for surfaces that are rough or uneven, and subject to considerable expansion and contraction, the *Pars* asbestos gasket holds steam, air, water, ammonia, and various other acid and alkali chemicals. Standard sizes have flanges 3/16 in. thick and 7/16 in. wide, and inside diameters from 2½ to 18 in. Special gaskets of larger sizes and square or oval gaskets can be made to order.

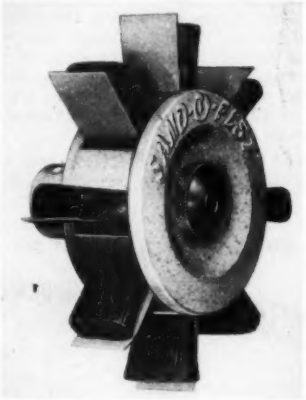
Lawton H Parsons, c/o J P Eldridge Advertising Co, 1015 Packard Bldg, Philadelphia 2, Pa.

LAUNDRY-WASHER CONTROL P726

Bulletin 723 laundry-washer control panels contain the necessary control equipment to perform the reversing and dwell function. They provide four reversals per minute with an adjustable dwell period.

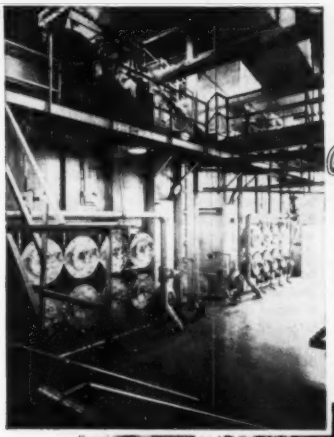
Panels are supplied for 2-wire control, operated from a maintained contact pushbutton, or 3-wire control, used with a momentary contact pushbutton. Dwell point between reversing periods is adjustable from ¼ to 10 seconds.

Allen-Bradley Co, Milwaukee 4, Wis.



SANDING WHEEL P753

Brush-back sanding device attaches to any rotating shaft for sanding and finishing curves and contoured surfaces. Model



10 UNION

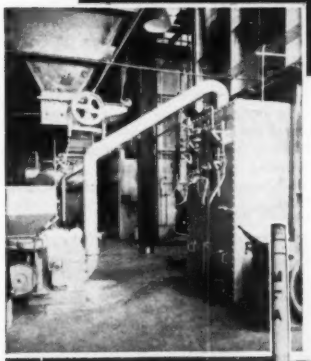
Steam Generators at

Producers Creamery Co.

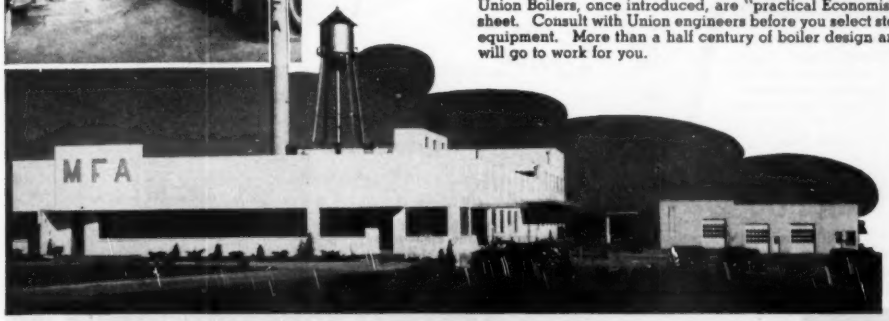
• SPRINGFIELD • MONETT • LEBANON
• ELDORADO SPRINGS, MO.

1st Choice for 16 Years

1934–2 Union "L" Type 265 HP Springfield
1940–1 Union "L" Type 265 HP Springfield
1945–1 Union "H" Type 533 HP Springfield
1946–2 Union "H" Type 603 HP Monett
1946–2 Union "H" Type 323 HP Lebanon
1946–2 Union "H" Type 323 HP Eldorado Springs



HERE is a running account of Union Boiler installations in 4 milk plants of Producers Creamery Company, Springfield, Mo.—an area believed to be the heaviest milk producer in the United States. Producers in 1928 at Springfield, Mo. handled only 100,000 pounds of milk per day for 1000 farmer patrons. Today, they operate milk plants at Springfield, Monett, Lebanon and Eldorado Springs, Mo. with a combined capacity of 2,150,000 pounds of milk daily for some 10,000 patrons. An official of this company says "Having had experience with the two Union Boilers installed in the Springfield plant in 1934, we purchased eight more of them for Springfield and the three new plants. This should give anyone a pretty good idea of our opinion of Union Boilers." Union Boilers, once introduced, are "practical Economists" on any cost sheet. Consult with Union engineers before you select steam generating equipment. More than a half century of boiler design and construction will go to work for you.



UNION IRON WORKS . . . *Since 1890*

373 CASCADE STREET • ERIE, PENNA.

BOILERS • PROCESS EQUIPMENT • FABRICATED STEEL

What Other Drive Gives You...
1. HIGH STARTING TORQUE
Smooth... positive... powerful — that describes a Duplex Steam Engine starting under full load. No clutch — no gear shift — no torque converter... just steady, continuous, direct power as your load comes up to speed — as slow or as fast as you require.
Plus
2 UTMOST FLEXIBILITY
3 SIMPLICITY, LONG LIFE
4 ACCURATE, FAST SPEED CONTROL
5 BY-PRODUCT POWER

Up to speed without a falter: This 300 hp. Troy Duplex Steam Engine brings a positive displacement blower up to speed smoothly, dependably, without jolts or surges. The constant torque characteristic of the engine is also ideally suited to this load.

Which Do *You* Need?

If your drive needs any or all of these five characteristics, the *modern* Troy Steam Engine is indicated. Send us your drive requirements and steam conditions, and our engineers will be glad to recommend the right type and size Troy engine to meet your needs.

Send for Bulletin 306

TROY

Troy Engine & Machine Co.

Power Equipment Division

2508 RAILROAD AVENUE • TROY, PENNSYLVANIA

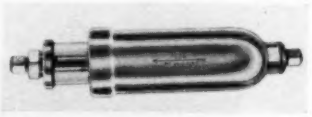
More EQUIPMENT NEWS

Begins on page 160

350 R is particularly recommended for portable electric drills and flexible shafts because it is lightweight and compact. The sander has eight replaceable brushes fastened to it. They back up and cushion eight strands of abrasive cloth, 1 in. wide, unwinding from a single core. As the wheel rotates, the abrasive strips mold to the contour of the work piece with a paintbrush action, and finish wood, metals, compositions, and other materials requiring abrasive operation. When the wheel rotates at normal speed it delivers 14,000 sanding strokes per min.

Merrit Products, Inc, 4023 Irving Place, Culver City, Calif.

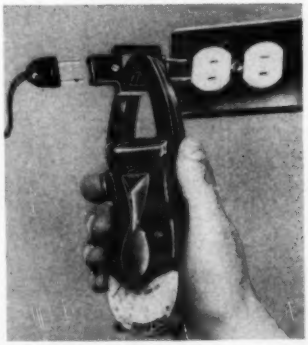
For more data on these items, use post cards, p169. Identify request with P and number.



LIQUID INDICATOR **P731**

Rapid, accurate check on refrigerating liquid level can be made in the field by service and operating mechanics with the new *Cee-Kleer* sight-gage liquid indicator. Combined with a sight-gage dryer, 100% cleanable and refillable, using a depth filter at the outlet side of the dryer to be free of pressure drop, the service mechanic can determine excess oil quickly and purge off as much as needed. Magnification of the stud in the center of the liquid indicator gives a full 360-deg visibility, according to its manufacturer.

Cee-Kleer Products Co, Cincinnati 10, Ohio.



SPLIT-CORE AMMETER **P714**

Sensitive ammeter designed for easier and precise readings on small appliances and motors of ¼ horsepower or less. Three low-current ranges now available in Model A-30 instrument: 0-1 amp, 0-2.5 amp, 0.5 amp.

Split plug shown above does not increase sinsitivity, but facilitates snap-on

FISHER®

Teflon*

V-RING PACKING CONVERSION KIT

A *Complete*

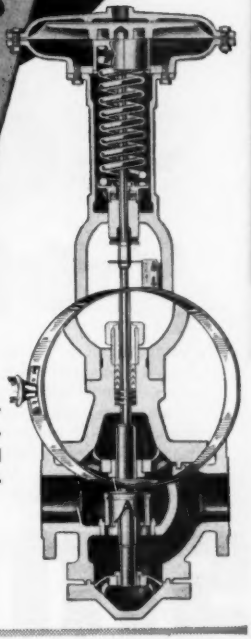
PACKAGED UNIT

This complete packaged Fisher Teflon V-Ring Conversion Kit converts a standard Fisher stuffing box unit to Fisher Teflon V-Ring Packing. It offers prompt service, guarantees a true fit and insures damage-free delivery.

When ordering, be sure to furnish the valve serial number found stamped on the patent plate attached to yoke or body.

* Teflon is the trade name of E. I. DuPont de Nemours & Co.

FISHER GOVERNOR COMPANY
Marshalltown, Iowa



Fisher Teflon V-Ring Packing is furnished as standard on new Fisher Diaphragm Motor Valves.

FISHER®

WORLD LEADER IN THE MANUFACTURE OF PRESSURE REGULATORS AND IN RESEARCH FOR BETTER PRESSURE CONTROL

41605

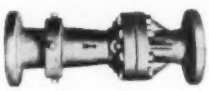
$Q = 28271.128 \times .987 \times d_1^2 \times \sqrt{H'} \Big/ \sqrt{\left(\frac{d_1}{d_2}\right)^4 - 1}$

WHAT TYPE OF VENTURI TUBE do YOU need?

1. Steel plate tube with cast iron throat section for measurement of clear water, air or gases.

2. Cast iron Venturi Tube with hand holes and cleaning valves at main and throat sections, for municipal sewage and trade wastes.

3. Cast iron Venturi Tube with flat invert and single cleaning valve at main and throat sections. Specifically used for sludge.



4. Cast steel or cast iron Venturi for hot or cold water and adaptable for boiler feed high pressure service.

IT'S SIMPLEX IT'S ACCURATE

SIMPLEX makes Venturi Tubes for measuring cold water, raw sewage, trade waste, sludge, process liquor, boiler feed, air and gases.

These tubes come in many sizes and different designs, some of which are pictured above. This means there's a particular tube to fit specific needs.

Write, stating your Venturi Tube requirements, to Simplex Valve & Meter Company, Dept. 7, 6780 Upland Street, Philadelphia 42, Pa.

SIMPLEX

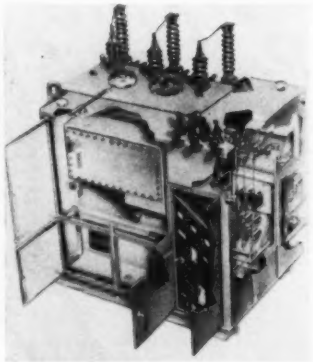
VALVE AND METER COMPANY

More EQUIPMENT NEWS

Begins on page 160

current readings of equipment having sealed double-conductor electric cord. When plugged in between equipment being checked and outlet, it separates conductors instantly without touching wire.
Pyramid Instrument Corp, 49 Howard St, New York 13, N. Y.

For more data on these items, use post cards, p169. Identify request with P and number.



TRANSFORMER UNIT P723

A number of improvements in the CSP line make the transformer simpler, smaller, and easier to ship and service. Number of doors and padlocks required to lock up the unit have been reduced so two padlocks now lock up four doors on front. The auxiliary compartment on the rear is eliminated. Potential transformers are now of the draw-out type to make fuse changing more convenient.

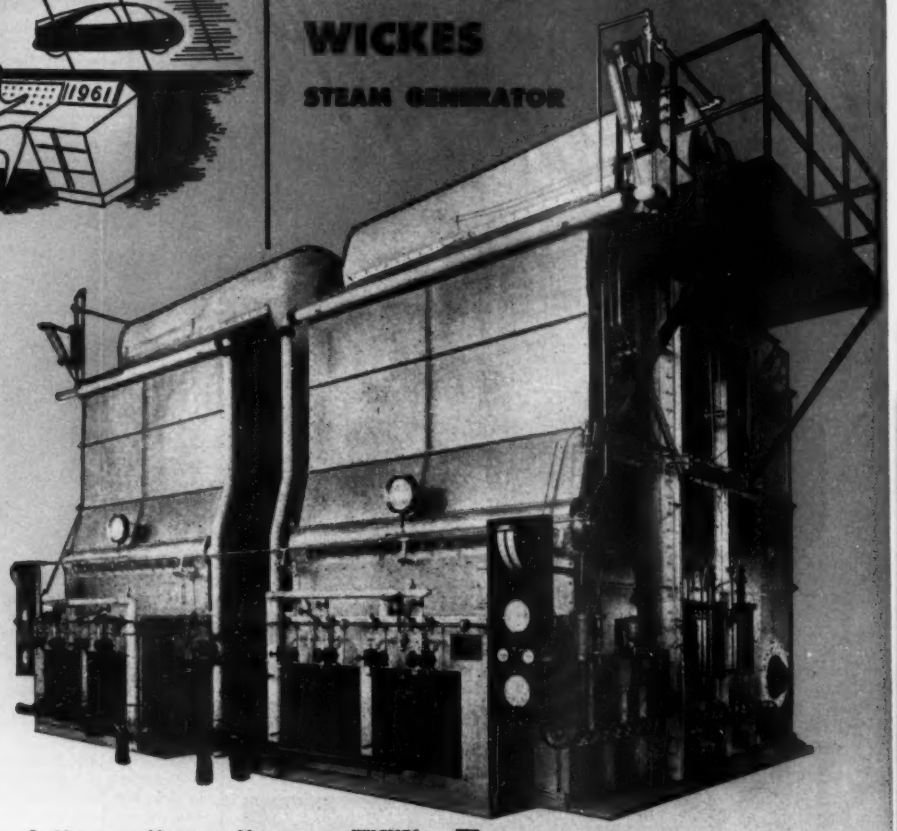
Arrester bracket is now welded to the tank on the high-voltage side to lower the profile. This improves the appearance and makes the arrester more stable. Removable frame formerly required for shipping has been eliminated by building the braces inside. It is no longer necessary to store these frames in anticipation of future relocation of the unit.

All standard ratings are now *Sealedaire*, permitting elimination of auxiliary compartment. This leaves more of the tank wall available for cooling and reduces floor-plan dimensions.
Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

TACHOMETER P732

Three-range, single-head, fixed-installation tachometer indicator for speed measuring applications, Series 42P, gives a particularly wide measuring range. Simple rotation of the indicator range knob selects one of three speed ranges covering from 40 or 50 to 1, based on readings down to 1/10th full scale of lowest range. Scales can give direct reading in any unit, such as rpm, fpm, in. per sec. The meter, with ordinary open wires, can be located up to

10 YEARS FROM TODAY
YOU WILL BE GLAD YOU INSTALLED A
WICKES
STEAM GENERATOR



In 10 years or 20 or even 30 years, your WICKES Boiler will still be going strong. For almost a century now, The Wickes Boiler Company has been leading the field in the manufacture of efficient high-pressure water tube boilers that are really built to last. Throughout the world, industries that depend on steam have learned by long experience that they can depend on WICKES Steam Generators. The Type S 2-Drum Boilers shown here have found wide acceptance in the chemical processing industry because they *are adaptable to any standard method of firing* — oil, gas, single retort underfeed or spreader stoker. Each of these Type S Boilers is capable of delivering 35,000 lbs. of steam per hour. And the low head design makes them especially practical where space is limited. WICKES can fill your requirements for steam generators up to 250,000 lbs. per hour and 930 lbs. per square inch. If you have a boiler problem, our knowledge and experience *is available to you without obligation* . . . write today for descriptive literature on WICKES' complete line of steam generating equipment.

WICKES

THE WICKES BOILER CO.
SAGINAW, MICHIGAN
DIVISION OF THE WICKES CORPORATION
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132

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You can't beat a DART for a snug drop-tight fit!

Why? The answer is easy! It's because Darts are made with greater care.

Take the joint, for instance! Both seats are made of resistant bronze; both are swaged into place under great pressure — permanently interlocked with the ends. And both are precision machined, then carefully spherically ground to give very wide, near perfect contact.

Finally — to protect the seats, give extra strength — ends and nut are made of *practically indestructible,* air-refined, high test malleable iron.

Little wonder Darts are drop-tight without excessive wrenching. No wonder you can use them again and again.

DART UNION COMPANY
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Boston New York Pittsburgh

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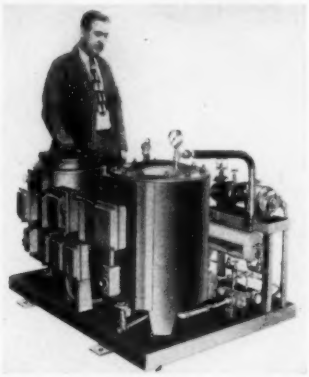
UNIONS

More EQUIPMENT NEWS

Begins on page 160

1000 ft from the head without materially affecting calibration. Selecting wrong range or other overspeeding will not damage the indicator.
Metron Instrument Co, 432 Lincoln St, Denver 9, Colo.

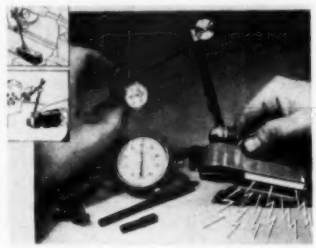
For more data on these items, use post cards, p169. Identify request with P and number.



OIL CONDITIONER **P711**

Unit is specifically designed for small-batch clarification of used hydraulic, lubricating, run-in and transformer oils. Both insoluble and soluble impurities are removed by unit combining a cartridge filter for removal of metal, gums, tars, residues, soot, carbon, dirt and sand, and a vaporizer for extraction of free and emulsified water, fuel dilution, air, gases, etc.

Advantages are simplicity, convenience and economy in purifying turbine, circuit breaker, transformer, vacuum pump, cable, compressor, hydraulic and refrigeration oils to "like new" condition. Over-all dimensions of the 25-40 gph oil conditioner are 54-in. wide, 42-in. deep and 37-in. high.
Filtration Div, U.S. Hoffman Machinery Corp, 219 Lamson St, Syracuse 6, N. Y.



INDICATOR HOLDER **P750**

Magnetic base holder of nonbreakable molded plastic 1¼ in. wide, 4 in. long, and 1⅝ in. high, has steel parallel ribs 2¼x¼x¼ in. for magnetic contact sur-

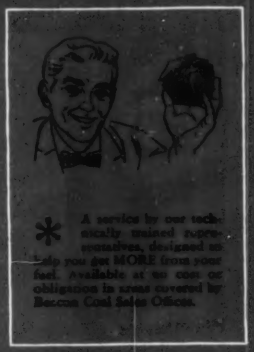
thinking of

expanding

your boiler house facilities?

maybe Beacon Combustion Service*

can help you in your planning



* A service by our technically trained representatives, designed to help you get MORE from your fuel. Available at no cost or obligation in areas covered by Beacon Coal Sales Offices.

Remember—a boiler alone, or combustion equipment alone, *can't generate steam.* It takes boiler *plus* equipment *plus* FUEL to make the system produce. And how well the elements are mated decides how well and how economically your new installation will operate.

In an existing operation . . . the fuel must be fitted to the installation. But in a NEW installation, you may be able to fit the *equipment* to the most desirable fuel—with a saving in money and a boost in output. The Beacon Combustion Service Man will be glad to review possibilities with you.

FOR EXAMPLE: Pre-selection of fuel will let you provide proper combustion space, grate design, etc., that may permit the completely efficient use of lower-cost fuel.

FOR EXAMPLE: Careful study of available coals may let you modify installation details, and fit the system to utilize any of several types, with high efficiency—broadening your source of supply as a hedge against emergencies.

FOR EXAMPLE: Addition of such items as draft gages, and motorized control, CO_2 meters, or similar equipment may frequently be justified many times over by the increase in efficiency.

We can't point out *all* the possibilities—these merely suggest a few. But a conference with the B.C.S. Man will give you all information on available fuels, plus reports on the experiences of other engineers with equipment, that will help you make a smart decision.

NOTE TO COAL DEALERS: If any of your commercial or industrial customers or prospects have a problem like this, your B.C.S. Man will be glad to speak with you in determining the cause—and recommending a solution.

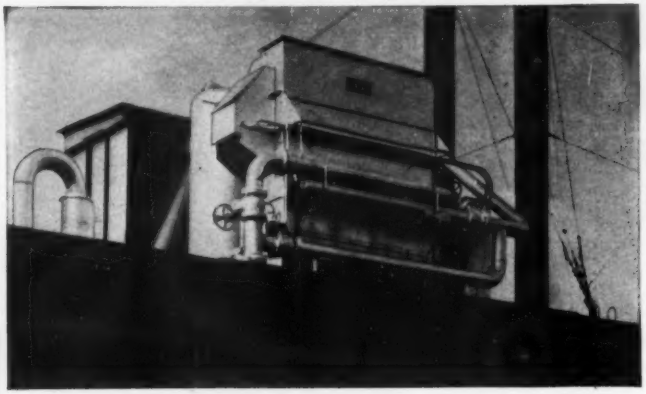
EASTERN GAS AND FUEL ASSOCIATES — BEACON COAL

EASTERN GAS AND FUEL ASSOCIATES

PITTSBURGH BOSTON CHICAGO CLEVELAND DETROIT NEW YORK
NORFOLK PHILADELPHIA SYRACUSE

For New England: New England Coal & Coke Co., *For Export:* Castner, Curran & Bullitt, Inc.

Direct saving of cooling water expense returns to you the cost of a Niagara Aero After Cooler in less than two years.



How to Get Drier Compressed Air:

It prevents many troubles and saves much expense

● NIAGARA AERO AFTER COOLER cools compressed air or gas below the temperature of the surrounding atmosphere. Therefore you get no further condensation in your lines. You save much in repairs to pneumatic tools and equipment; you save much interruption to production; you save water damage in paint spraying, in air cleaning, in any process where compressed air comes in contact with your materials or parts in manufacturing (sand blasting, for example).

Niagara Aero After Cooler uses evaporative cooling, saving 95% of your cooling water consumption. This saving quickly returns the cost of the equipment to the owner or makes extra cooling water available for other processes.

The Niagara Aero After Cooler produces compressed air with 30% to 50% less moisture than by ordinary cooling methods. Other Niagara equipment provides bone-dry air for processes requiring it.

If you have an air problem or a cooling problem, a Niagara engineer probably has an answer that will improve your process or save you operating or maintenance expense.

Write for Bulletin 98

NIAGARA BLOWER COMPANY

Over 35 Years Service in Industrial Air Engineering

Dept. P, 405 Lexington Ave. New York 17, N. Y.

Experienced District Engineers in all Principal Cities

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More EQUIPMENT NEWS

Begins on page 160

face on bottom of unit. A magnet release of helical design, fingertip-operated, connects to the bottom. At the top of the unit is a 4-in. post with ball stem pocket and locknut construction. Set includes accessories for accommodating all stem-type, hole-type and lug-box indicators so all dial indicators can be held in place.

The desired dial indicator is attached by a suitable adapter to the magnetic face folder and the unit placed to bring the dial contact point into position for test. The unit bottom is designed so it can be mounted on flat, round or curved surfaces, or even on a shaft or pipe.

Enco Mfg Co, 4522 W. Fullerton Ave, Chicago 39, Ill.

For more data on these items, use post cards, p169. Identify request with P and number.

GLASS FILTER **P754**

Replaceable air-filter unit can now use the *Glasfloss Roll-Pak* made up of long fine glass fibers having low air resistance, high filtering efficiency, and moistureproof fire resistance for filter medium replacement. *Roll-Pak* is made up in standard-size rolls 40 in. wide and 10 ft long in both 1- and 2-in. thicknesses. It is packed five rolls to the carton and provides air-filter coverage of 167 sq ft. All that needs to be done is to roll out the material, cut to size and place between screens.

Glasfloss, 155 E. 44th St, New York, N. Y.

VOLTAGE REGULATOR **P724**

Latest development in connection with the *Regulex* rotating amplifier-type generator voltage regulator is the voltage measuring and control panel that has no moving parts or electron tubes. This static regulating equipment is built in standardized panel sections, which can be mounted either in a convenient cubicle or in switchgear units. It consists of a compensating unit for reactive current division, stabilizer panel, static voltage-measuring

PROTECT STEAM and AIR RODS AGAINST WEAR WITH

ANCHOR "SECURITY WEDGE" PACKING

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SECURITY WEDGE packing is an ideal combination fabric and metallic packing for reciprocating steam and air rods, steel and cast iron plungers. The metal wedge forms a perfect anti-frictional metallic surface against the rod or plunger. The continuous segmental wedge center is surrounded by a substantial asbestos cloth channel, to which it is securely fastened. The asbestos channel insures to the finished packing the resiliency to hold the metallic member in proper contact with the moving rod at all times. This packing can be supplied in either ring or spiral form and can be depended upon to give long service with low friction and without wear to the rod on which it is used.

Recommended for the following: Piston rods of high speed and Corliss engines, large and small valve stems, expansion joints, oil rods, plungers, steam hammers, shotgun feeds, stock pumps in paper mills and for all other stuffing box requirements where a good grade of semi-metallic packing is required.

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FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

STOP GUESSING!

ADSCO CONDENSATE METERS

will TELL you where your steam went!

As fuel costs climb, it is imperative that you *know* the amount of steam used by each building, department or process. Install economical, accurate ADSCO Rotary Condensate Meters wherever all the condensate can be recovered . . . in either vacuum or gravity systems. Thousands are already in use . . . in heating systems, hot water heaters, cooking equipment, laundry equipment, unit heaters, blast coils and heat exchangers of all kinds using steam as the heating medium.

ACCURATE WITHIN 1% The ADSCO Condensate Meter is accurate to within 1% for all rates of flow from zero to 150% of rated capacity.

LOW INITIAL COST Simplified design and standardized construction result in an installed cost below other types of meters.

EASILY INSTALLED No elaborate piping required. Manifold is available so that connections can be correctly located before actual installation.

EASILY SERVICED Disassembly for inspection or cleaning is simple and easy. With manifold, meter can be removed without disturbing the connecting piping.

Capacity (Pounds per Hour)	Dimensions (Inches)			Wgt. (Lbs.)
	Height	Width	Depth	
250	11⅝	12¾	8⅝	34
500	11⅝	12¾	10⅛	41
750	17⅜	16⅞	10	70
1500	17⅜	16⅞	13	80
3000	23¼	25⅜	15¾	171
6000	23¼	25⅜	22⅜	230
12000	31	31⅜	27⅜	453

Available in seven sizes from 250 to 12,000 lbs. per hour. For further information mail the coupon. There is no obligation.

CHECK BOXES BELOW

☐ Please send Bulletin No. Z-35-80 completely describing the ADSCO Condensate Meter.

☐ Please have representative call.

☐ Please quote price and delivery on ADSCO meter of

☐ 250 ☐ 500
☐ 750 ☐ 1500
☐ 3000 ☐ 6000
☐ 12000 lbs. per hour

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Title_____

Company_____

Address_____

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More EQUIPMENT NEWS

Begins on page 160

circuit, a battery excitation switch and resistor, and a damping transformer assembly, mounted from top to bottom in the cubicle.

Knob on front of reactive compensating units adjusts the autotransformer, while reactors and other units are mounted on rear of panel. Stabilizer panel consists of transformers giving rate of change signal, capacitors and resistors. It operates to compensate for the time delay, inherent in machine fields, due to the inductance of the field.

The *Regulex* exciter as a regulator is quite versatile when applied to the control of synchronous machines. Standard elements are available not only to control voltage, power factor or current, but also to prevent over- or under-excitation.

Allis-Chalmers Mfg Co, Milwaukee, Wis.

For more data on these items, use post cards, p169. Identify request with P and number.

FORGED-STEEL GAGE VALVE P704

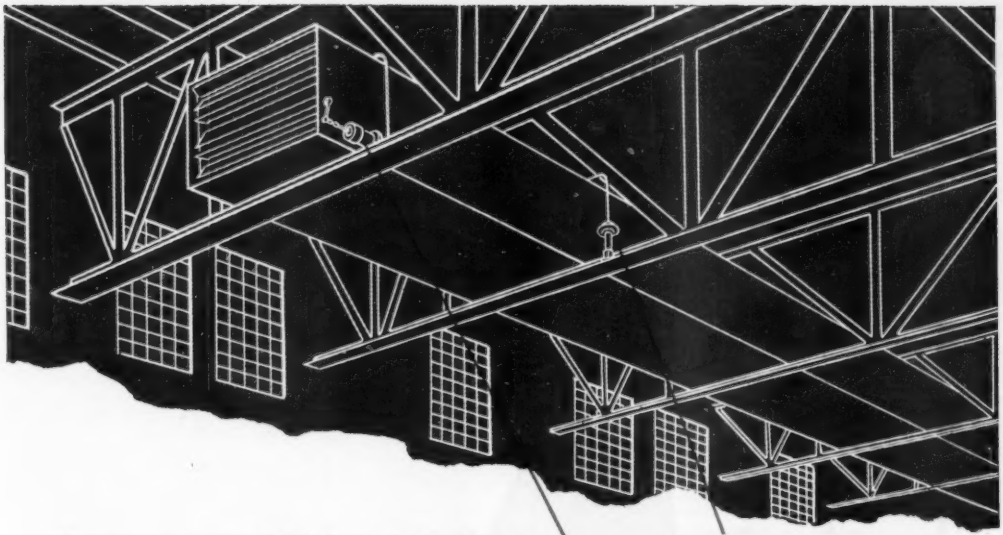
Identical in design detail to this firm's gage valves with female connections on both ends, this unit has a male inlet and female outlet. Valve needs no nipples when hooking pressure gages to pressure tubing or casing, nor for other connections. Male inlet serves as nipple. Wall thickness of inlet is extra heavy for high pressures and gives greater protection against breaking off or rupture. Globe design is designated as Fig. 152J, angle as Fig. 153J. Ratings are 4000 lb at 150 F or 600 lb at 750 F. Valve size is ½ in.

Edward Valves, Inc, East Chicago, Ind.

SCREW DRIVER P742

Pistol grip screw driver has been added to the ED portable electric-tool series. It is available in speeds of 500, 800 and 1000 rpm, in all straight and 25-deg-angle models, and 660 and 880 rpm in right-angle models with positive kickout and double slip clutches.

Independent Pneumatic Tool Co, 175 N. State St, Aurora, Ill.



Inaccessible Valves and Dampers

ARE CONVENIENTLY OPERATED BY

JOHNSON *switch* CONTROL

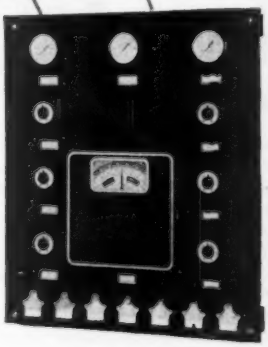
In many installations, valves and dampers often cause serious situations because they are in "out-of-the-way" places. When such equipment is to be operated *automatically,* Johnson temperature control apparatus is engineered for dependable results, regardless of its location. *For manual operation,* exactly the same types of Johnson valves and dampers can be installed at inaccessible locations and connected to Johnson switches placed at suitable remote points.

Valves and dampers may be positioned for partial flow or they may be opened or closed, depending upon the type of Johnson switches selected.

For partial flow conditions, a turn of the knob on a Johnson "Pilot Type" Gradual Switch changes the pressure in the small compressed air line leading to a Johnson pneumatic valve or damper, and operates such equipment, easily, from a remote point. Here, also, is a manual means of readjusting remotely placed thermostats and humidostats or to reset Johnson Pilot Positioners, obtainable as an auxiliary feature on Johnson valves and damper operators to insure accurate, steady, partial flow.

Other Johnson switches, such as Three-way Pneumatic Push-button and Lever-handle types, provide two-position, "open-closed," action for pneumatic dampers or diaphragm valves. Important applications of switch control are found in connection with modern heating and ventilating installations which require the operation of remote and inaccessible dampers and valves from a central switchboard, conveniently located for those in charge of plant operation.

Johnson switches, like all Johnson apparatus, are neat and practical —engineered to assist in working out modern controlling and operating problems. Call a Johnson engineer from a nearby branch office. JOHNSON SERVICE COMPANY, Milwaukee 2, Wisconsin. Direct Branch Offices in Principal Cities.



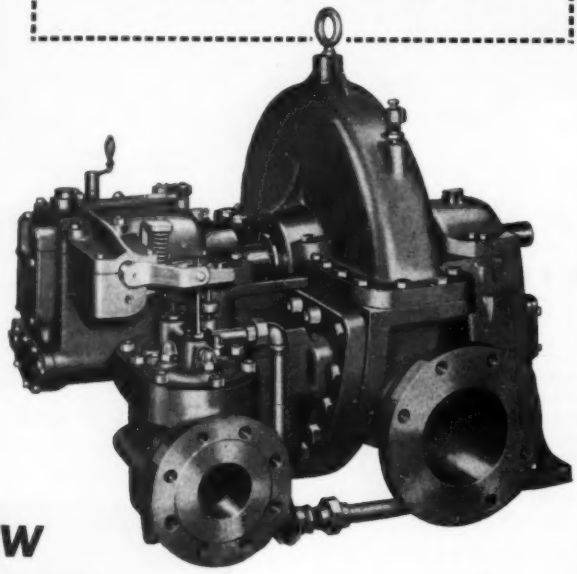
JOHNSON *Automatic Temperature and Air Conditioning* **CONTROL**

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

NEW! MURRAY

TYPE H

MECHANICAL DRIVE SINGLE STAGE STEAM TURBINE



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FEATURES

- Enclosed 'shaft-through' governor
- Fast acting hand speed changer
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- New convenient hand valve position
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- Large finned-tube oil coolers
- Magnetic oil-drain plugs
- New type split oil rings
- Corrosion resistant carbon packing cases
- Chrome plated shaft under carbon rings

Combining a host of new improvements plus time tested features, the Murray Type H offers extra-value in a medium size machine. With a range of 50-200 H.P., depending upon speed and steam conditions, it is offered with either a 16 or 20" diameter wheel. 3" or 4" steam inlet sizes available. Steam conditions up to 600#, 750° and back pressures up to 150# can be used.

Write today for full details.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

More BOOKSHELF

Begins on page 172

the general equations developed are applied to the calculation of transient short-circuit currents and torques, steady-state power, torque and current; both in synchronous operation and during starting. Further application of the equations are made in the calculation of voltage disturbances occasioned by sudden application of load.

Emphasis is on the rigorous mathematical development and on obtaining a fundamental physical understanding of the behavior of synchronous machines. Thus the reader is equipped to extend the theory as he needs it and to attack new problems.

CODE FOR PRESSURE PIPING, ASA B31.1-1951. *Sponsored by ASME.* 101 *pp,* 8½x11, *illus, tables, paper,* $3.50. *American Society of Mechanical Engineers,* 29 *W* 39 *St, New York* 18, *N.Y.*

To bring this Code in line with current practice most of the text of the 1942 edition has been revised and much material added. For example, revised "Lists of Material Specifications" contain a number of new specifications and the latest effective dates of existing ones. Tables of allowable stresses include values for new material; ambiguous or conflicting requirements have been clarified. Pressure-temperature ratings of Supplement 1 of "Standard on Steel Pipe Flanges and Flanged Fittings" have been adopted; there are provisions for pressure-seal valve bonnets and welded bonnets.

Contents include power, gas and air, oil, district-heating and refrigeration piping systems; fabrication of pipe hangers, supports, anchors, sway bracings, vibration dampeners and pipe joints other than welded; expansion and flexibility provisions; welding of pipe joints; welded branch connections and fabricated or cast specials; materials—their specifications and identification. Every engineer who designs, selects or purchases pipe should have a copy of the Code on hand.

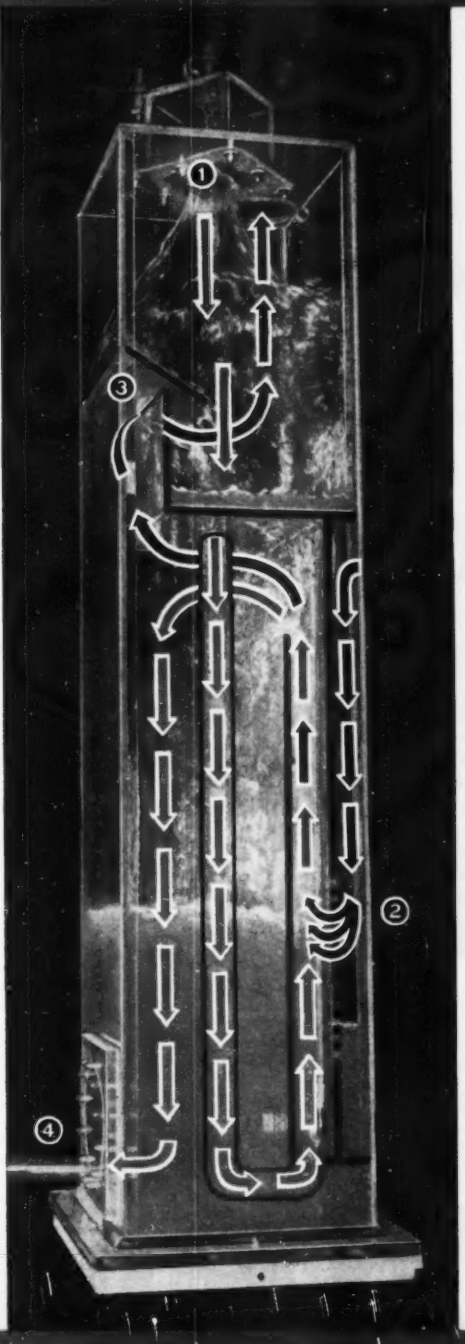
HOW TO RUN A LATHE, *50th edition,* 8¼x5¼, 128 *pp,* 350 *illus, paper* 25c, *imitation leather,* $1. *South Bend Lathe Works, South Bend* 22, *Ind.*

Reference source for skilled machinist and textbook for student has 11 chapters, written in nontechnical language. It covers items such as correct installation and leveling of the lathe, grinding cutter bits, turning, boring, thread cutting, taper turning, drilling, reaming, tapping, machine-ability ratings, and cutting speeds for steels.

BASIC THERMODYNAMICS (1951). *By C L Brown, asst professor of mechanical engineering, Purdue University.* 266 *pp, illust, tables,* 6¼x9¼, $4.50. *McGraw-Hill Book Co,* 330 *West* 42*nd St, New York* 18, *N.Y.*

A short course for engineering students who have had an elementary course in power plants. The number of pages show that this book is intended for quick, brief treatment of the subject. Because of prerequisite in heat power instruction, the book includes no descriptive material of heat power machinery, confining itself

ONE LOOK IS WORTH 1,000 GUESSES . . .



See for Yourself How the

PERMUTIT DEAERATOR

Removes All Oxygen and CO_2

This transparent model of Permutit's Deaerating Heater is a perfect picture of the operating ease and efficiency of the real unit it represents. Here are a few of the reasons why many engineers call it the best equipment for deaerating boiler-feed make-up water:

The Permutit Deaerator recovers waste heat economically, prevents corrosion of feed lines, stage heaters, economizers, and boilers, and is itself corrosion-free. It operates noiselessly and is adaptable to varying steam pressures. Above all, its simplicity of design insures a minimum of expense and attention for maintenance.

Write for full details to The Permutit Company, Dept. P-7, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

1. FIRST STAGE. Cold water, entering here, is heated almost to steam temperature by *spraying* it through steam. This removes 95% of the oxygen. The water then travels downward through the pipe toward the second stage.

2. SECOND STAGE. Here the partially deaerated water is intimately mixed with steam entering through the scrubber. Violent boiling and vigorous scrubbing is assured for both light and heavy loads, and deaeration is completed.

3. The steam from the scrubber travels upward and enters the first stage of the heater, where it partially deaerates incoming water. The remaining steam is then vented to the atmosphere.

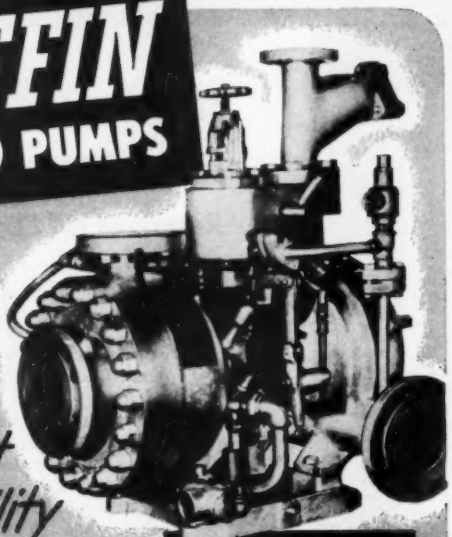
4. Here the completely deaerated water settles and may be drawn off. Ample water storage space is provided below the water control level.

Water Conditioning Headquarters for Over 38 Years

PERMUTIT

COFFIN TURBO PUMPS

combine **performance** AND **service** *for utmost dependability*



COFFIN TURBO PUMP MODEL TC adaptable for tank cleaning, fire lines, boiler feed, general service.

Single Stage Provides 3 to 12 Stage Pump Performance

- STEAM PRESSURES TO 850 PSI
- BACK PRESSURES TO 200 PSI
- PUMP CAPACITIES TO 500 GPM
- DISCHARGE PRESSURES TO 1100 PSI
- HEADS TO 2400 FEET
- LIQUID TEMPERATURES TO 300°F

These are the pumps marine and industrial engineers count on for high efficiency operation with minimum steam consumption. Matched pump, turbine and governors are engineered in one compact, lightweight assembly with all parts made to gauge and replaceable without fitting. Rigid one piece steel casing and heavy shaft with ample clearance prevent damage from dry operation. High pumping efficiency combined with high speed, two-bucket row turbines conserve steam. Check, now, on all the features that make Coffin the leading choice for tough pumping jobs in every industry!

***Ask for free* FILE FOLDER**

the new Coffin File Folder on Turbo Pumps is completely illustrated and contains all the facts, operating data and specifications needed for general industrial, marine, and railroad pumping applications. Call or write for your copy, today!

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mostly to the theoretical aspects. The book emphasizes steady-flow processes but also discusses nonflow types.

Special formulas have been avoided, with each problem considered as a variation of a general case. The numerical examples incorporate detailed analysis of the problems, rather than routine applications of formulas. In addition to basic theory, the book shows its application to heating and cooling, compressors, pumps, expanders, vapor-power cycles, gas-power cycles, refrigeration, nozzles and mixtures of gases and vapors. The book ends with a brief chapter on heat transmission.

HANDBOOK OF POWER RESISTORS. *By H F Littlejohn Jr of Ward Leonard Electric Co. 195 pp, 5x7½-in., $3. Published by Ward Leonard Electric Co, Mount Vernon, N.Y.*

This book is designed to cover the field of power resistors from their practical construction to application and performance characteristics. Following the introductory chapter, dealing with fundamental definitions, standards, functions and calculations applicable to power resistors, the author discusses construction and later selection.

Various-type power resistors are covered, from the low-wattage vitreous-enameled wire-wound to high-current ribbon-wound types. Data on the performance and application of each type is included. The author includes information on selection, standard stock types and sizes, along with steps in manufacturing vitreous-enamel resistors.

NEMA resistor standards are reproduced along with basic definitions needed in the intelligent application of power resistors.

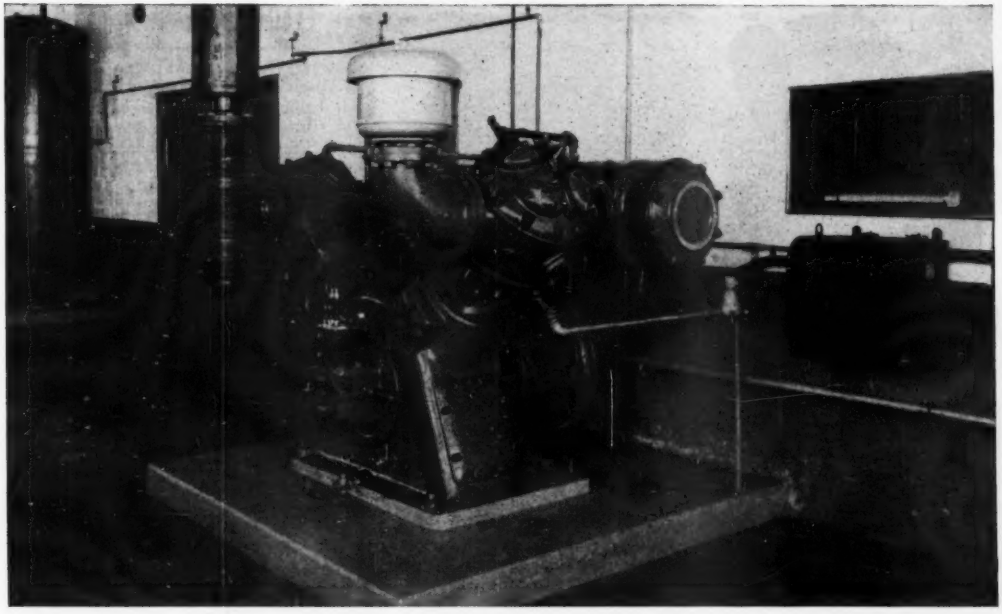
AMERICAN STANDARD MALLEABLE-IRON SCREWED FITTINGS, 300 *lb, ASA B16.19-1951, 12 pp, 8½x11, paper, $0.60. American Society of Mechanical Engineers, 29 W 39 St, New York 18, N. Y.*

This standard covers pressure ratings, size, marking, material, tolerances, threading, ribs, fitting dimensions, plugs, bushings, locknuts and face bevel for 300-lb malleable-iron screwed fittings. Following introductory notes are a series of illustrated tables showing dimensions of fittings. Piping designers can obtain much useful data from this standard.

BOILER-WATER TREATMENT MANUAL FOR FEDERAL PLANT OPERATORS. *By Louis Goldman, 5¾x9¼, 94 pp, Bureau of Mines Handbook, No. 5, paper, 30c. Supt of Documents, U. S. Government Printing Office, Washington 25, D. C.*

This booklet follows up an earlier one, Booklet No. 3, designed to explain why feeding chemicals into boilers prevents scaling, corrosion and caustic embrittlement. The new manual tells how to accomplish these aims for boilers of the pressure range used in most Federal plants.

The author is supervising chemist of the Bureau of Mines Boiler Water Service Section at College Park, Md. He describes the two basic methods of chemical feeding —internal and external. From here the concentration is on internal feeding. In addition, material is given on corrosion control in return lines, and boiler lay-ups.



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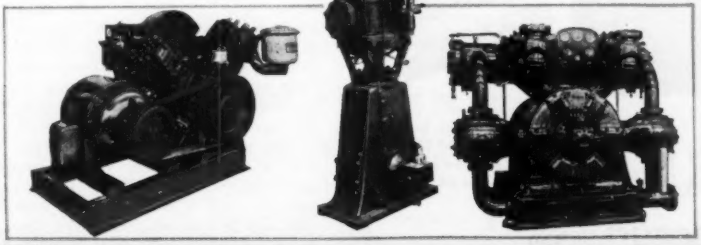

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ELECTRONICS

Continued from page 79

bias on T_2 to zero. Maximum current will then flow through T_2 and R_5 to raise the bias on T_1 to, say, block this tube. Since no current flows in coil DS, the saturable reactor phase-shifts the bias on tube T_6 and T_7 to reduce the current through them and the motor speed to a low value.

If contact A_2 is set in a midposition as shown, then the minus bias on T_2 cannot be made less than the volts' drop across the lower half of P_2, less volts' drop across R_{10} and R_{11}. Say this bias gives 250-rpm motor speed. This is the speed obtained with A_1 in its top position and is the lowest at which the motor can be operated by adjusting P_1. By turning A_1 counterclockwise, motor speed can be raised to rated value, but clockwise movement of A_1 cannot reduce motor speed below 250 rpm. So by positioning contact A_2 on P_2 any desired minimum speed can be set within the limtis of the control.

Speed Rate of Change. Resistor R_{12} and capacitor C_2 help control the rate of change in armature speed. For example, assume P_1 is suddenly changed to cause a large increase in tube T_2 grid bias. Capacitor C_2 is in a circuit from A_1 through resistors R_{14}, R_{11}, R_{12}, R_5 to B. Before the increase in grid volts can become fully effective the charge in capacitor C_2 must be increased to the new value. Resistance of this circuit is high so C_2 charges slowly. As a result the grid volt rises comparatively slowly as does the motor speed, because of the volts' drop across R_{14} and R_{11}.

Armature Volts' Adjustment. Potentiometer P_3 controls the volts' drop across resistors R_{10} and R_{11}, consequently the change in minus bias on tube T_2 and motor speed for a given setting of P_1. If we cut P_3 out of circuit, current flowing from cathode to grid of T_2 is limited only by resistors R_{10}, R_{11}, R_{13} and R_{24} and is at a maximum. Consequently volts' drop across R_{10} and R_{11} is at a maximum so adjusting P_1 has a minimum effect in increasing the armature volts and speed.

On the other hand, if contact A_3 is moved to its top position all of P_3 that has 0.25 megohms resistance is in circuit, and current flow in the circuit will be at a minimum. Volts' drop across R_{10} and R_{11} will also be at a minimum and a change in armature volts will be least effective in reducing the minus bias on T_2 grid. Then adjusting P_1 will have a maximum effect in changing the armature volts and its speed.

This adjustment is provided to compensate for manufacturing tolerances in the parts making up the voltage

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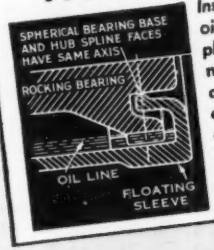

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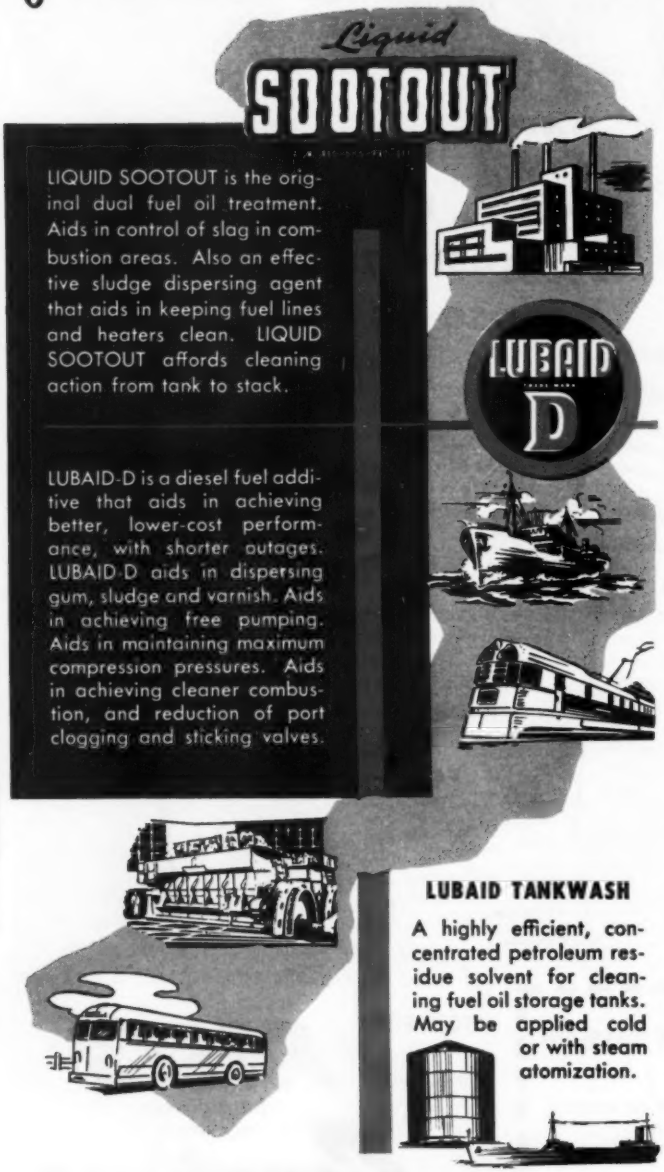

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ELECTRONICS

Continued from page 192

control circuits. It is set at the factory to produce 230 armature volts at full field, which gives rated speed at full load. Turning A_3 clockwise decreases armature volts and its full load speed, whereas turning contact A_3 counterclockwise increases armature volts and speed.

Armature Volts' Stabilizer. Potentiometer P_4 and capacitor C_6 stabilize the armature voltage and speed control. With P_4 cut out of circuit, capacitor C_3 is connected across R_{13} and P_3. Then any increase in armature voltage will first be absorbed across R_{10}, R_{11}, R_{13} and R_{24}, while C_3 is being charged to the new voltage. This causes a sudden rise in current in the circuit and a like increase in volts' drop across R_{10} and R_{11} to reduce the minus bias on T_2 grid. The armature volts and speed would then tend to drop suddenly, which we wouldn't want to happen.

If all of P_4, which has 1 megohm resistance, is in circuit, the rise in voltage across R_{10} and R_{11} will be too slow to give proper control of armature volts and speed. To get smooth operation P_4 is normally set at some point between its two terminals. This is best determined by observing the armature power tubes. P_4 is set so flickering of these tubes is at a minimum. Correct capacitance of C_3 depends on the load's inertia.

IR-Drop Compensation. When current flow increases in the armature as when load increases, the voltage drop in the resistance of the armature conductors increases and speed decreases. To hold constant speed the armature's terminal volts must be increased by an amount equal to the increase in volts' drop. This is done with the current transformer primaries PT_3 and secondary ST_3.

The two primaries PT_3 are connected so current flow in one is opposite to that in the other. This gives an ac voltage in secondary ST_3, which is continuously loaded through resistance R_{16}. This is necessary in a current transformer to prevent its secondary voltage going too high and its primaries developing high reactance in the circuit and other objectionable effects.

Secondary ST_3 supplies a dc current from its center tap through IR drop potentiometer P_6, resistor R_{21} and tube T_{10}. Potentiometer P_6 applies a minus bias to the grid of tube T_2, from contact A_6 through resistor R_9, grid to cathode of T_2 to D and E through R_{21} to tube T_{10}.

If the load increases on the motor, current flow increases through primaries PT_3 to increase the voltage of ST_3 and the dc volts across P_6. This increases

more than 200,000,000 lbs/hr of post-war steam generating capacity

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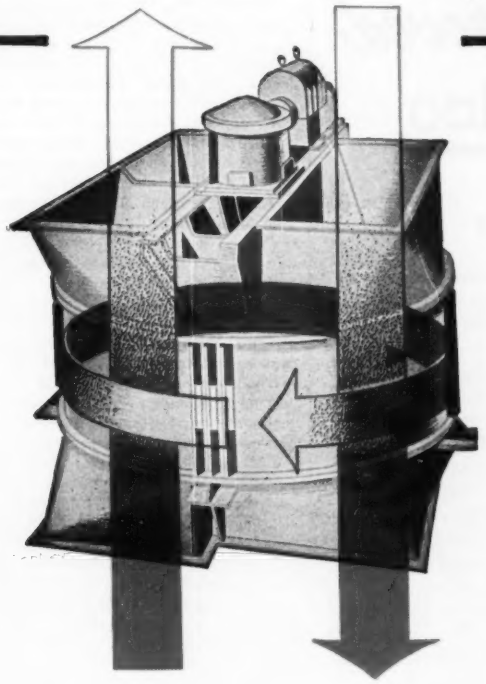
AIR PREHEATERS



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ELECTRONICS

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the minus bias on the grid of tube T_2 to increase the armature volts to where speed will remain constant. The bias applied to T_2 grid in effect subtracts from that part of the armature volts being used as a feedback, to raise the voltage across the armature when load increases.

The adjustment of P_6 permits setting for partial- or over-compensation. If arm A_6 is at the bottom, total volts' drop across P_6 is applied as a minus bias to the grid of T_2 to give maximum voltage increase across the armature when load increases. Moving contact A_6 to its top position in effect connects A_6 to E to remove the IR-drop bias from tube T_2, and the voltage across the armature does not rise as load increases and speed decreases. Setting A_6 at some intermediate point gives the correct IR bias on T_2 grid to hold constant armature speed.

Current Limit. The armature IR-drop compensation in combination with tube T_4 is also used to limit the armature current to a fixed value to prevent overloading the motor. Potentiometer P_5 connects across voltage-regulating tube VR_1, and has the voltage of this tube applied to it. Part of the voltage across P_5 is used as a minus bias on the grid of tube T_4. This voltage is applied from contact A_5, through R_{19} and R_{20}, from grid to cathode of T_4 to F.

Current flows from A_5 through R_{19} and R_{20}, and from cathode to anode of tube T_3. This current causes a voltage drop across resistors R_{19} and R_{20} that reduces the bias on the grid of T_4 by an equal amount. This bias is normally high enough to prevent T_4 conducting. Normally tube T_3 holds the grid of T_4 just minus enough to block the tube to make the current-limiting control act faster when it comes into action.

Current flow through R_{21} causes a voltage drop that is applied as a plus bias from F, through T_4 from cathode to grid, R_{20}, R_{27} to T_{10}. Normally this bias is less than the volts' drop across R_{20} and is not effective. But when the motor current reaches, say, 150% full-load, current transformer ST_3 causes a proportional current to flow through resistor R_{21}, and increase voltage drop across this resistor.

This voltage is higher than that across R_{20}, and suddenly drives the grid plus in tube T_4 and this tube conducts. Its circuit is from F through T_4, resistor R_5 to tube T_5. Because of the current flow through R_5, tube T_4 takes control of the armature voltage and current away from tube T_2.

The more current that flows through R_5, the higher the minus bias on T_1, and the lower the current in dc coil DS

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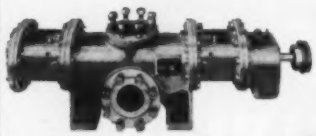

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ELECTRONICS

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of the saturable reactor. This phase shifts the bias on the grids of tube T_6 and T_7 to reduce armature volts and current to hold the overload on the motor within safe limits.

If the overload continues beyond a set period, overload *OL* in the armature circuit opens contact *OL* in the start circuit and trips the motor off the line. Then it will not start again until the relay is reset and the start button pressed.

Assuming the overload or other cause of excessive current ceases within a short period, bias on tube T_4 becomes enough minus to block this tube. Then, tube T_2 again controls armature voltage and speed according to the setting of P_1.

Overload Selection. Potentiometer P_5 selects the overload that can be applied to the motor before current-limit tube T_4 takes control. When A_5 is on the bottom end of P_5, full voltage of tube VR_1 is applied across R_{19}, R_{20} and tube T_3. Current flow in this circuit will be at a maximum as will voltage drop across R_{20}. To overcome this voltage and drive T_4 grid plus will require a high current through R_{21} to give the needed voltage drop.

Moving A_5 to its top position connects it directly to the cathode of T_4 to remove the minus bias from this tube. It then takes over control of the armature current when the motor is lightly loaded. From this we see that moving contact A_5 down increases the overload and moving it up decreases the overload at which tube T_4 takes over control of the armature voltage.

When starting from rest there is no current to generate a current-limit voltage, and armature voltage is zero. Therefore, for the first few cycles, current could be very high. To prevent this, normally closed contacts CR_1 and CR_2 are used to give a false signal in the current-limit circuit. Capacitors C_4 and C_6 are charged, and remember this signal for a short time after contacts CR_1 and CR_2 open when contact GM_2 closes to energize the armature. These capacitors serve the same purpose as the current-limit transformer ST_3 to prevent excessive armature current until the normal current-limit system becomes effective.

A thyrite resistor connects across current-transformer secondary ST_3 to protect it against voltage surges. Resistance of thyrite decreases rapidly as voltage across it increases. For example, when the voltage applied to a thyrite resistor is doubled, current flow through it increases at least 11 times. When the voltage returns to normal, resistance of the thyrite also returns to its low-voltage value.

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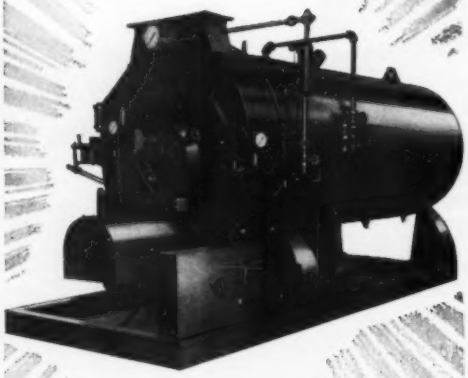

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MARMADUKE

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"'I usually give my boilers aboard ship a hydrostatic every time I clean them,' I told him. 'Fresh water is scarce at sea and we can't afford to have it leak out. I open the feed check after the cold boiler is full and let the main feed pump keep boiler pressure on while I look for leaks. It's not the real McCoy of one and a half times boiler pressure, but it's enough.

"'Then when I spot a leak, I drop the water level and give the leaky tube a few rolls with the tube roller. It's surprising how many weeping tubes I've found that way.

"'You see, son,' I continued, 'the water from those slow leaks flashes to steam when the boiler is steaming. The steam goes up with the exhaust gas and usually no one knows about it. Besides wasting water, you waste the fuel it took to heat that water.'

"But I saw this was over Bob's head. I dropped the water to the bottomglass nut and asked him to light off. Then I looked up Jackson and advised him to put a more experienced man in charge.

"'Hell's bells,' wailed old Jackson, 'What's wrong with young Bob? He's got a strong back and can yank a throttle well as the next guy. He stays sober and besides, I don't have to pay him but a few dollars more than when he was firing. You inspectors don't seem to know there's a lotta competition in the paper business and I gotta cut corners to stay afloat.'

"'You're gonna cut more than a corner some day,' I predicted, 'because I've yet to see a power plant pay off by trying to save money with green help.'

"Jackson opened his mouth, but I cut him short. 'At sea a fireman puts in four years of firing and oiling before he can even sit for an examination. And then he's only a third assistant. A second, first and chief engineer keep an eye on him. By the time he's in charge of a plant, it's taken a good seven years. By that time he's probably been on all kinds of ships and learned from all kinds of engineers. Besides that, he's had to study for four examinations.

"'Now you put this green kid in charge of your expensive machinery. And he doesn't even have anyone to lean on out here. Why hell, Jackson, a good engineer saves you his salary a dozen times over!'

"'I'm within the law,' cut in Jackson, getting pink around the gills. 'And if your firm won't insure me, there's plenty others who will.'

"I shoved off fast before I blew a gasket. That night I made out the report. My boss wrote me in Greenville next week. His letter said that my job

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PRINCIPLE

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FEATURES

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High accuracy maintained
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PRINCIPLE

The principle of operation used in the Hays Condu-Therm Meter is that of thermal conductivity of gases, i.e., that all gases conduct heat at different rates.

FEATURES

Electrically operated
Electronic type recorder
Temperature controlled
Humidity controlled
No chemicals required
No moving parts in analyzer
Continuous sampling
No drying agent required
Easily installed glass and corrosion resisting sampling system
Not affected by wide change in gas flow rate
Rapid response
High sensitivity
Continuous recording
Remote mounted analyzer
Remote mounted recorder
12" 24-hour chart
CO_2 Recorder and Indicator
As many as 4 records on same chart
Low maintenance

Hundreds of these meters have been in operation for many years in all types of plants burning all kinds of fuels and saving thousands of fuel dollars.

PRINCIPLE

Operates on Orsat principle of Volumetric measurement and chemical absorption. Extremely simple: sample of flue gas trapped and accurately measured; passed through chemical which removes CO_2 component of gas mixture. Sample is re-measured, volume compared to original sample. Difference before and after absorption gives exact percentage of CO_2 absorbed by chemical.

FEATURES

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Water operation
Pressure and temp. compensated
Volumetric determination
Chemical absorption
2 minute operating cycle
Easily understood
Rugged construction
Low maintenance
Available in 6 remote mounted types and 3 integral types
Remote or integral mounting
10" 24-hour chart
Available for: (a) CO_2 only—recording with or without indicator (b) CO_2 and flue gas temperature recorder combined (c) CO_2, draft or flue gas temperature recorder combined

Provides a QUANTITATIVE guide to efficiency — deals with quantities of air and steam; by contrast CO_2 and O_2 meters are QUALITATIVE guides since they determine directly quality of combustion gases. Both Boiler Efficiency Meter and Gas Analysis Meter are used to obtain advantages of both methods.

PRINCIPLE

Pounds of air required to burn each pound of coal vary widely with heating value of coal; constant weight of air is required to produce same Btu. Similar relationship exists when oil and natural gas are used as fuels. Record of steam flow is assumed to be Btu's produced; record of air flow is calibrated to flow of air required to generate that steam.

FEATURES

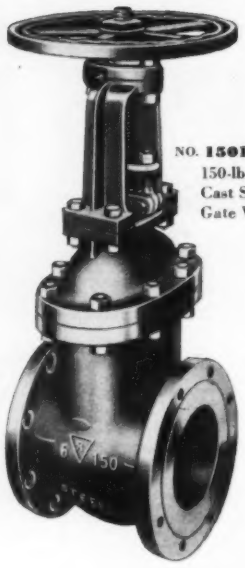
Electric operation of flow meter and air flow recorder
Diaphragm type air flow measuring unit
Air flow measuring element does no work
Air flow recorder—motor operated
Adjustable cam air flow calibration
Mercury transmitter—pressures to 2500 psi
Interchangeable range tubes for steam flow
Remote mounted steam flow transmitter
No high pressure piping into panel
Easily installed and adjusted
Low maintenance

THE **HAYS** CORPORATION

MICHIGAN CITY 3, INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

R·P&C
VALVES



NO. **1501**
150-lb.
Cast Steel
Gate Valve

Throughout Industry—It's R-P&C for Quality Cast Steel Valves

- R-P&C Cast Steel Valves are on the job throughout industry helping to maintain uninterrupted production with their long and trouble-free service.
- Your R-P&C distributor has them—or can get them for you. Your nearest R-P&C district office will gladly furnish details about the line.

ACCO
Atlanta, Baltimore, Boston, Chicago, Dallas, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

"Intentionally Better"
READING-PRATT & CADY VALVES

was to inspect boilers and to go easy on advising owners about their help. After a few months of inspecting down there I understood what he meant. Practicing simple safety that most operators know in license states was hopeless.

"A few months later the boss wired me in Spartanburg. 'GO TO PULPBURG PAPER MILL AND INVESTIGATE BOILER EXPLOSION,' said the wire. I got there late that night.

" 'What happened at the mill?' I asked the hotel clerk.

" 'What happened?' he echoed, looking surprised. 'You mean what *didn't happen*. The mill's darned near wiped clean off the map—that's what happened.' But that's about all anyone could tell me then.

"Next morning I got in my model-T before breakfast and snooped around. The powerhouse was gone, along with half the mill. I found hrt-boiler parts all over the scenery.

"About 600 ft away near the river, I ran across part of a boiler shell, with the safety valve attached. The valve was wedged shut. That was enough for me. I hurried to look up Jackson.

"But Jackson had entered the Pearly Gates, along with others. I found Bob Cuttner, the 'engineer,' bandaged up in bed at his home.

" 'What in hell happened?' I asked him.

" 'How should I know?' he answered. 'All I did was to give the old hrt a pressure test like you gave the two new boilers. While Sam the fireman looked after it I left for the mill because the foreman squawked about not getting enough water to fill a stock box. About the time I started back I heard the explosion. A piece of lumber came flying through the mill and caught me on the shoulder. That's all I know.'

" 'I found a gagged safety valve on the exploded shell,' I informed him. 'I won't ask why you gagged it, but I'd still like to know what exploded the boiler.'

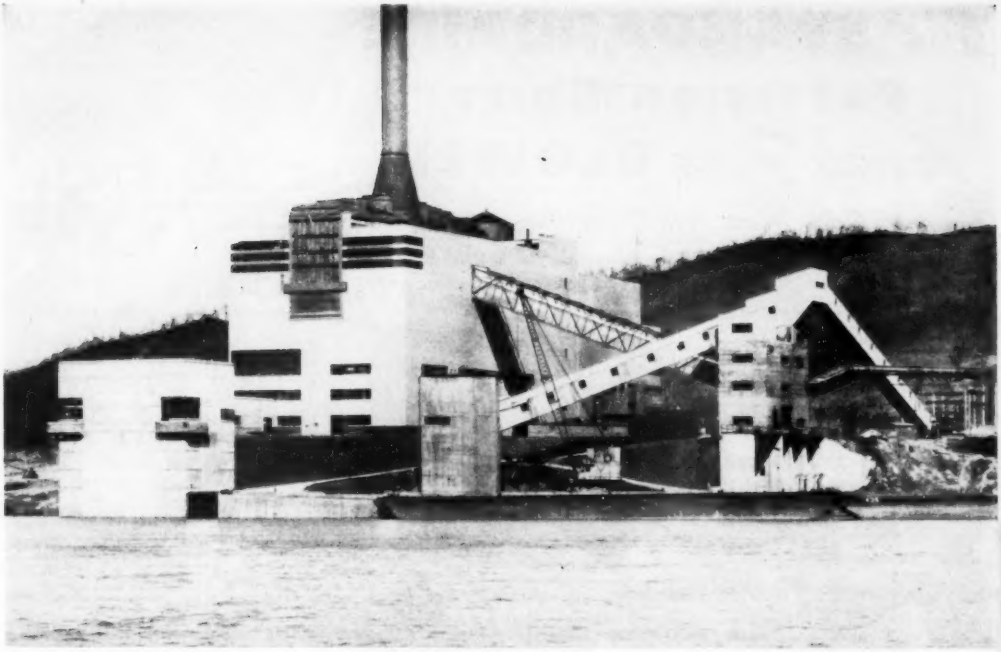
" 'Well,' said Bob, 'I thought I'd test that old boiler for leaks like you did the new ones. But I figured I'd save time by making the test while she was steaming. So I wedged the valve like you did and had Sam raise the steam from a hundred to a hundred and fifty pounds.'

" 'YOU DID WHAT?' I asked, not believing my ears.

" 'I know that wasn't so bad' explained Bob, calmly, 'but I guess that damn fool Sam musta let that steam go above a hundred and fifty pounds. Do you think that's what did it?'

"That afternoon I sold my flivver and caught the next train to Baltimore.

" 'I'm signing off this job,' I told the district inspector, throwing my inspector's kit on his desk.



Unique Circulating Water System Installed in This Power Plant

The R. E. Burger steam-electric plant of Ohio Edison Company is located on the Ohio River well above flood stage—which may reach as much as 60 feet above extreme low water. Water is supplied to the condensers by a patented circulating water system pioneered jointly by Worthington and the consulting engineer, Mr. George W. Saathoff.

All major equipment except circulating pumps, which are designed to operate completely submerged if necessary, are located above flood stage.

The new installation of a Worthington 70,000 sq ft two-pass condenser and auxiliaries, serving a 90,000 kw turbine-generator, is the third Worthington unit in this station. Two 46,000 sq ft condensers were previously installed.

For advice on any new installation or information on a wide range of power plant equipment, consult Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, New Jersey.

HOW IT WORKS

Two full-capacity circulating pumps are used in series.* The primary pump, submerged below extreme low water, is a Worthington motor-driven HIFLO. Its high starting head characteristic is able to deliver enough water for starting purposes. A booster pump—a single-suction volute Worthington MIXFLO, mounted directly upon an hydraulic turbine—starts when there is enough water in the control well. The two pumps then operate automatically in series at full capacity.

Advantage is taken of maximum siphon effect from the condenser drop leg which enters the sealing or control well. From this well, all circulating water is passed through the hydraulic turbine. Thus the static head from sealing well to river level is utilized—75-80% being recovered—in reducing the work of the primary pump, with saving in overall pumping power.

The booster pump functions until rising water renders the turbine ineffective. Then the primary HIFLO works alone, producing full capacity under reduced head.

*In the new unit, there are two half-capacity primary pumps, permitting operation of only one in the winter when low water temperatures prevail.

Z.1.1

WORTHINGTON

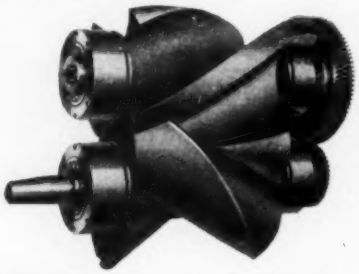
WORLD'S BROADEST LINE OF STEAM POWER PLANT AUXILIARIES

Feed Water Heaters	Boiler Feed Pumps	Steam Turbines
Steam-Jet Ejectors	Water Treating Equipment	Surface Condensers

The STANDARDAIRE
PRECISION BUILT
Axial Flow BLOWER

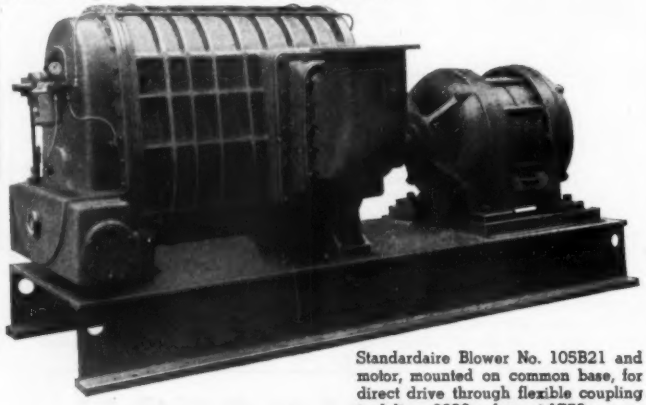
Features Two More Vital Components:

PRECISION ROLLER BEARINGS—spherical type are used on the fixed ends of the rotor shafts and a cylindrical type on the floating ends. With such a design free aligning action of the rotor shafts is assured and specific speed, load, and service requirements are easily met. In addition, this bearing construction fully compensates for any housing distortion which might occur due to temperature differentials.



LABYRINTH TYPE OIL SEALS—Bearings and gears are lubricated by a spray of filtered oil. The oil is controlled by a balanced pressure, labyrinth type seal which gives complete oil control and assures absolutely clean air delivery under all operating conditions.

Such features as precision bearings—frictionless oil seals—hardened, shaved, helical gears—contribute immeasurably to the efficient and dependable performance of the Standardaire Blower—A Modern Machine with Superior Operating Characteristics. For further information write READ STANDARD CORPORATION, Dept. E-4, 370 Lexington Avenue, New York 17, N. Y.



Standardaire Blower No. 105B21 and motor, mounted on common base, for direct drive through flexible coupling to deliver 3200 c. f. m. at 1750 r. p. m.

BLOWER-STOKER DIVISION

FORMERLY The Standard Stoker Co., Inc. ONLY THE NAME IS CHANGED

READ STANDARD CORPORATION

NEW YORK • CHICAGO • ERIE • YORK • LOS ANGELES

"'Why Mr. Surfaceblow, what's wrong?' he asked, looking up in surprise. 'You've been doing some mighty good work down there.'

"'Good work my eye,' I barked, 'How in hell can a guy do good work when the cards are stacked against him? I'm grabbin me a ship—a mud scow—anything that floats, just so long as her engineers come under safety regulations. I intend living a while longer.'"

ASH REMOVAL

Continued from page 80

overheated when running with zero flow after shutting the valves. To prevent pump damage, ½-in. recirculating lines were run from each pump discharge into the service-water return header. This header discharges to the cooling tower. These lines, normally left open, keep a small flow through the pumps to prevent overheating.

The recirculating lines were also used to prime the pumps. The suction valve would be nearly closed for a short time during starting. This, however, didn't remove the air from the suction line. When the discharge valve was opened the piping would undergo a heavy swing as a "slug" of air passed through pump and valve. To eliminate this, air-operated siphons were installed atop each pump. These remove all air from the suction piping and draw water up into the pump.

In the meantime the wiped bearing from the East motor was cleaned up and found in good condition. So it was installed on the West motor. On starting, this motor was extremely noisy and sparks were noted between shaft and bearing housing. Phase currents were equal and normal when checked. Both stator and rotor vibrated with the noise volume, setting up a beat about once per second. As the load increased the beat became faster and noise louder. The motor was returned to the manufacturer. Bearings were refitted and motor checked and inspected. But when returned to the plant it still acted up as before, but without the bearing sparking.

More Trouble. While holding discussions with the manufacturer, the motor was held for a possible spare. Then the East pump suddenly gave trouble with noise and vibration. Packing would only stand up a day or two. After several renewals, a maintenance man noticed that the outboard end of the shaft had a little play, while the coupling stood still. Tearing down the pump we found the shaft broken inside the impeller hub.

A stone, about the size of a small hen's egg, was lodged in the impeller inlet eye. This had thrown the pump

Steel saved civilization at Augsburg

FOR 2000 years, the western world has survived vast waves of Asiatic invaders who threatened to destroy it. Repeatedly, the fate of civilization and Christianity has seemed to hang on the outcome of a single battle.

Such a decisive action was fought at Augsburg, South Germany, in 955 A.D. Swarming out of Asia, savage Magyars overran the rich Danube Valley. They ravaged the prosperous lands of Germany, Italy and France. At last, under Otto, King of Saxony, the armored Knights of Christendom rallied. They faced a hundred thousand fierce foes. The battle raged all day. Thousands were slain. At last the tide turned and the Magyars fled. For three days the Knights pursued the scattered enemy, killing or capturing thousands more. Symbolic of the west's predominance in weapons and armor of iron and steel, victory was credited to King Otto's iron-tipped Holy Lance.

Augsburg ended the Magyars' attempts to conquer Europe. They settled down to peaceful living in their valley and within 50 years accepted Christianity. Again, history demonstrated the truism that no people or alliance can establish supremacy unless it first predominates in the production and use of iron and steel.

It is reassuring that America produces twice as much steel as the rest of the world combined. America has the steel to win. We will use enough of it to protect our leadership of a free Christian world.

Scrap Metal is Critical Again

The Youngstown Sheet and Tube Company

General Offices—Youngstown 1, Ohio
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MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.

Steam plus CORAVOL (The Original* AMINE PROCESS) ® equals Protection (FROM CORROSION)

Because CORAVOL Circulates to Control Corrosion

CORAVOL circulating throughout your steam system protects it from corrosive attack. **CORAVOL** saves costly pipe repairs and replacements—maintenance labor—hours and days of shutdown loss. **CORAVOL** cleans out clogging rust deposits, improving heat transfer, restoring original capacity of lines and efficiency of valves and traps.

CORAVOL, the original* amine process, has the flexibility that lets it conform to each individual need. The **CORAVOL** *you* will use is formulated to do the best protective job under your own plant conditions.

CORAVOL IS PART OF A COMPLETE TECHNICAL SERVICE which provides special formulas of chemical treatment for: boiler feed water . . . hot water supply . . . refrigerating brine . . . cooling and condenser water . . . rapid scale removal . . . coagulation . . . algae control . . . fuel oil supply . . . soot removal.

*The use of **CORAVOL** in steam systems is covered by U. S. Patent No. 2053024. The Western Chemical Co., owner of this patent, grants licenses under which volatile AMINES purchased from other sources may be used in steam systems upon payment of royalty to Western Chemical Co.

Chemical Water Treatment

WESTERN CHEMICAL COMPANY

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Complete Data about the CORAVOL Process

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Send me full information about CORAVOL.

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out of balance, causing fatigue and failure of the shaft. Pump wearing rings and packing sleeves, which were badly worn and out of round, also had to be replaced. While we waited for repair parts, the East motor was installed to drive the West pump.

We finally decided that the West motor vibration and noise must be from a defective or open bar in the rotor of the squirrel-cage motor. The manufacturer built a replacement rotor and after some months it was installed. The West motor now drove the rebuilt East pump. The old rotor had no observable defects, but with the new rotor the motor operated quietly and normally. The case against the old rotor seemed quite conclusive.

Fortunately all these headaches never forced the boiler off the line—but just how much trouble can you have?

More POWER NEWS

Begins on page 154

Plus-Performance Plan. This plan, in preparation for the past six months, consists of a complete and integrated system of manuals, articles, specifications, bulletins, record cards and charts. This printed material explains how to choose, install, charge, maintain, inspect, test batteries.

The prepared folio, which constitutes a reference file on the subject covered, will be promptly forwarded, without obligation, to the inquirer. Should specific questions be asked concerning special problems, Gould's engineering staff will prepare and forward an individualized study and recommendations. Finally, a request on a special field problem will bring Gould's field engineers to inspect the batteries themselves without obligation.

COMING EVENTS

July 2-4—American Society of Heating and Ventilating Engineers, semi-annual meeting, Multnomah Hotel, Portland, Ore. B W Farnes, general chairman, ASHVE, 418 Failing Bldg, Portland, Ore.

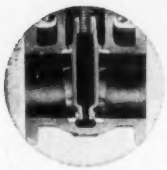
Aug 20-23—American Institute of Electrical Engineers, Multnomah Hotel, Portland, Ore. R S Gardner, assistant to secy, AIEE, 29 W 39th St, New York 18, N. Y.

Sept 10-14—Sixth National Instrument Conference and Exhibit, Instrument Society of America, Sam Houston Coliseum, Houston, Texas. ISA, 921 Ridge Ave, Pittsburgh 12, Pa.

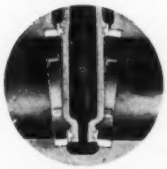
Sept 25-28—American Society of Mechanical Engineers, fall meeting, Radisson Hotel, Minneapolis, Minn. O B Schier, chairman, ASME, 29 W 39th St, New York 18, N. Y.

Brown-Boveri's 220-kv airblast circuit breakers, used in **Grand Coulee Dam** powerhouse, have successfully interrupted up to 11-million kva in 2½ cycles, never reached before in air breakers.

(*Continued on page 228*)



Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.

Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.

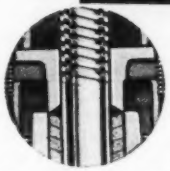
WALWORTH

iron body gate valves

with screwed or flanged ends

... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.



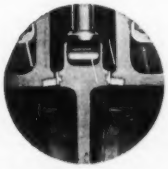
Brass Liner on Glands assures greater resistance to corrosion and scoring.

WALWORTH

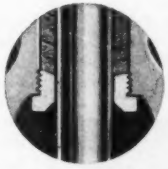
valves and fittings

60 EAST 42nd STREET NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

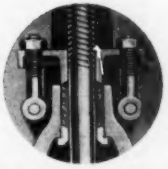


T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.



Bronze Back-Seat Bushings in bonnets of OS&Y valves.

Solid Web Type Disc in OS&Y valves for greater strength and longer service.



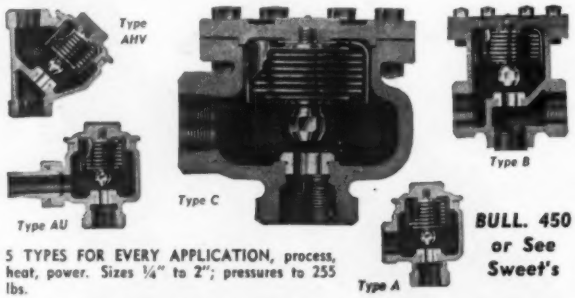
Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

In This Plant Nicholson Traps

SAVED 10% IN STEAM COSTS

Chief Engineer H.F.D. stated, after Nicholsons replaced mechanical traps in his plant: "Saving in steam waste cut our fuel cost at least 10%. Yet application temperatures were up 30°-40°. And relief of all air binding effected faster warm-up."

Operate on lowest temperature differential; 2 to 6 times average drainage capacity; maximum air venting. For other advanced Nicholson features send for Bulletin 450.



5 TYPES FOR EVERY APPLICATION, process, heat, power. Sizes ¼" to 2"; pressures to 255 lbs.

BULL. 450 or See Sweet's

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Problems in WATER TREATMENT are rightly solved when you call in the RIGHT ANSWER people. Refinite's Sales & Service Staff blankets the nation, and there is a representative close enough to give you neighborly service. Merely get in touch with Norm Tucker at Refinite in Omaha. He will have the Refinite man nearest you get the necessary details concerning your problem, and forward to the RIGHT ANSWER Service in Omaha . . . for immediate attention.

Today . . . ask the girl on the switchboard to get *Norm Tucker* of RIGHT ANSWER Service . . . ORchard 3000 . . . Omaha. Or, write. Address: Right Answer Service, Refinite Corp., P. O. Box 1312, Omaha, Nebraska.

Refinite

WATER REFINING EQUIPMENT
OMAHA, NEBRASKA

More TECHNICAL BRIEFS

Begins on page 158

all efficient precipitator. These curves, however, do not apply to all collectors of a given type. Each and every cyclone, for example, has its own curve. To apply such typical curves for a specific boiler it is necessary to know particle size distribution and specific gravity of the flyash.

Comparative costs between the various collector devices are shown in Fig. 2, above. From this we can see that the initial cost of a collector to handle, say, 50,000 cfm of gas runs about $5700 for a low-draft loss collector, $7800 for high-efficiency cyclones, and $30,000 for a 90% efficient electric precipitator. *APSPAA paper, no number.*

HIGH-TEMPERATURE GAS CLEANING, *by J M Kane, American Air Filter Co, Inc.* Applications where hot and often moist gas containing considerable quantities of solids discharge to the atmosphere require effective collection equipment not generally provided because of the expense and difficulties involved.

Removal of flyash from pulverized fuel and spreader stoker-fired boiler-stack gases is an exception to the general problem of high-temperature gas cleaning. Dry-type centrifugal collectors have been accepted for stack gas cleaning in these instances.

It is doubtful, however, if the degree of removal accepted for flyash collection would be enough from the public-nuisance standpoint for process industries. Regulation of gas cleanliness using a visibility yardstick, such as the Ringelmann Chart, fails miserably against a background of industrial emission. The only effective devices today are wet-dust collection. Collection efficiency is high on particles in the small micron size. What's more, the high-temperature or moisture-laden gas, or both, can be handled without too much difficulty. The major shortcomings are troubles from corrosion where acid-forming gas or materials attack the metal collector surfaces. *APSPAA paper, no number.*

Directions for ordering papers on p 158

A REPORT OF THE ATMOSPHERIC CONCENTRATION OF SULFUR DIOXIDE IN ST. LOUIS, *by J J Schueneman, Industrial Hygiene Section, Division of Health.* Back in 1936 and 1937 the Air Hygiene Foundation of America, Inc, now the Industrial Hygiene Foundation, published a comprehensive report of concentration of volatile sulfur compounds in several cities, including St. Louis. In 1950, a survey was run to determine present concentrations and compare them wtih earlier reports. No statis-

WORLD'S LARGEST TURBINE PUMPS

Interesting Data

ON THESE GIANTS IN THE WORLD OF MOVING WATER

LOCATION: Chelsea, N. Y., 60 miles north of City of New York.
PROJECT: Pumping plant to augment supply to Delaware Aqueduct from Hudson River.
CAPACITY: 100 million gallons a day to be supplied by 5 pumps. Sixth pump for standby use rated at same capacity, namely 14,000 gpm.
LIFT: Rated head 575 ft. but suitable for efficient operation for heads between 525 and 625 ft.
MOTORS: Six 2500 hp motors @ 900 rpm; 3 phase, 60 cycle at 4,000 volts.
PERFORMANCE: Overall efficiency required 75%. Pumps tested exceeded requirements, giving overall efficiency from 83.4% to 87.7%.
PUMPS: 6 Peerless close-coupled vertical turbine type; 5 stages, 36" diameter bowls. Discharge size: 24".
PURCHASER: Board of Water Supply, City of New York.
GENERAL CONTRACTORS: Tuller Construction Co.; A. S. Dillenbeck.

NEW 100 MILLION GALLON A DAY PLANT FOR THE CITY OF NEW YORK USES SIX 2500 HP PEERLESS VERTICAL CLOSE-COUPLED TURBINE PUMPS

Another first for Peerless,—first to apply 2500 hp to power a vertical close-coupled turbine pump. Six of these tremendous Peerless pumps, the world's largest, are now installed, tested, accepted and in operation at Chelsea, N. Y. to supplement the water supply of the City of New York. The complete success in the design, manufacture and application of these giant Peerless pumps, which in test exceeded required overall efficiency by 8 to 12 percentage points, is added evidence as to why Peerless is Amercia's largest manufacturer of vertical turbine pumps. Look to Peerless for continued leadership in the economical production of water for municipalities, industry and agriculture. Peerless turbine pumps are described in two bulletins, B-141 and B-159. Write for your copies today.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

Address Inquiries to Factories at:
Los Angeles 31, California or Indianapolis 8, Indiana
Offices: New York, Atlanta, Fresno, Los Angeles, Chicago, St. Louis, Phoenix; Dallas, Plainview and Lubbock, Texas; Albuquerque, New Mexico.

WESTON *Readable* ALL-METAL THERMOMETERS

—AVAILABLE IN THESE 3 TYPES

STANDARD INDUSTRIAL THERMOMETERS

All-metal dial types with stainless steel stems, in straight and angle forms. Scale lengths 3"—6" and 9", with stems from 2½" to 72". Available as testing thermometers, and for general purpose and heavy duty service. Ranges from −100 to +1000°F. All-metal construction prevents breakage, assures dependable accuracy for longer periods.

CONTACT MAKING THERMOMETERS

Combines the features of the all-metal indicating thermometer with an alarm or control device. Has adjustable contact arm mounted in the glass and bezel. Supplied to make contact on increasing or decreasing temperatures. Has positive magnetic type contacts. Contact rating . . . 100 ma at 110 volts a-c; 50 ma at 110 volts d-c. Stem lengths 2½" to 24".

MAX-MIN® THERMOMETERS

Equipped with a manually set red index which moves up or down scale with pointer, remaining at extreme temperature reached until reset. Thus one reading gives present temperature, and maximum or minimum reached since last reading. Available in scale lengths of 6" and 9"—stem lengths 2½" to 24".

Literature describing Weston all-metal, as well as electrical and glass thermometers, sent on request. WESTON Electrical Instrument Corporation, 626 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and TAGliabue instruments.

WESTON *Instruments*

More TECHNICAL BRIEFS

Begins on page 156

tically significant comparison could be made because it was not definitely known whether periods covered by the survey were ones of average pollution or of unusually high or low pollution.

Winter phase of the 1950 survey was conducted on 27 different days between February 23 and March 31. The summer phase was run on 21 days between June 5 and July 29. Samples were taken on all days of the week and at all hours. They were arranged to give full chronological coverage to each sampling station. The paper furnishes tables showing the average SO_2 concentrations, maximum SO_2 concentrations, and number of samples for both winter and summer and for both surveys. *APSPAA paper, no number.*

EXPERIENCE WITH SILICA-REMOVAL DEMINERALIZER PLANTS, *by S B Applebaum, Cochrane Corp.* Silica-removing demineralizers are now being installed for high-pressure boiler plants instead of evaporators. A brief survey of the research development in the field of ion exchange, which led to this result, is given. Development of sodium zeolite — then hydrogen zeolite to remove alkalinity in addition to hardness so as to overcome the difficulties from sodium zeolite alone—then the weak-base anion exchangers which remove sulfate and chloride, but not silica—fluoride method of removing silica — and, finally, the various strong-base anion exchangers to remove silica are covered.

An actual silica-removal demineralizer at the Prairie Creek Station of Central Iowa Cooperative at Cedar Rapids, is described. *MWP paper. No number.*

Directions for ordering papers on p 158

Water Treatment

BOILER FEEDWATER TREATMENT FOR HIGH PRESSURE HIGH-MAKEUP PLANTS, *by J Harlow, Philadelphia Electric Co, V J Calise and M Lane, Graver Water Conditioning Co.* Selecting a demineralizer for Philadelphia Electric Co system resulted from a long search for the most economical method of increasing steam supply to a district-heating setup operated by the company in Philadelphia.

As the load on this district system grew, additional steam supply had to be furnished. It was decided to connect to the Schuylkill Station, about a mile and a quarter from the southwest corner of the steam-heating system. Considerable economies could be gained if the steam from the copper turbine at Schuylkill could be made available. *MWP paper. No number.*

(*Continued on page* 212)

1500 Pounds at 1000°F.

Vogt

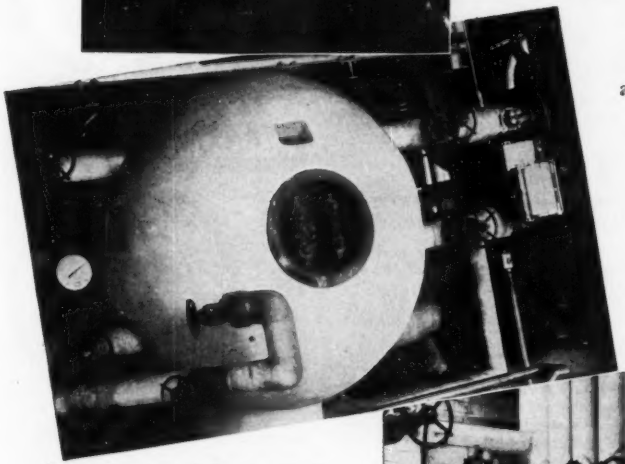
DROP FORGED STEEL

CHROME-MOLY STEAM VALVES

Hold the line at...

Oswego, N. Y. Station of

* NIAGARA MOHAWK POWER CO.



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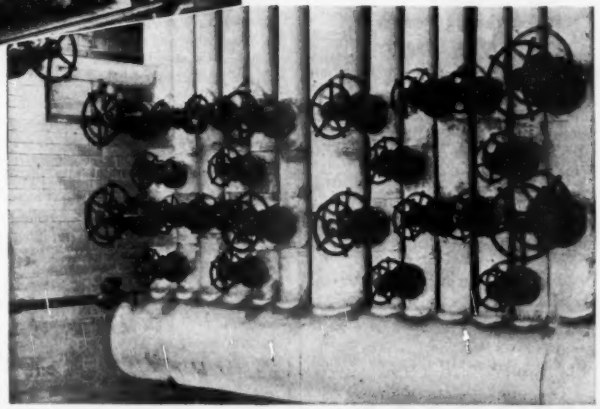

TOP: Air view of Oswego, N. Y. Station of Niagara Mohawk Power Co.

CENTER: Valves on main drum of 875,000 pounds per hour steam generator.

RIGHT: Drains from main steam, attemperator, and superheater lines employ a maze of valves.

NEW CATALOG F-9
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FEEDWATER TREATMENT IN THE PACKING HOUSE, *by M B Golber, Armour & Co.* As boiler design has progressed and heat-absorption rates have increased, better conditioning of boiler water and makeup had to come along. The author's company has studied very closely developments in this field.

Makeup water for this concern's plants may be drawn directly from wells, rivers, lakes or municipal supplies. Qualities cover extreme ranges from Denver, where little treatment is required, except caustic soda, for alkalinity correction, to Peoria where hardness sometimes exceeds 32 grains per gallon with considerable calcium, magnesium, bicarbonate and sulphate content. Condensate returns may reach one-third of the steam-generating load, but are not always recovered.

A number of factors must be reviewed in choosing water treatment for any particular installation on the company's properties. These factors may be chemical, mechanical economic.

Usually many factors covered by the questions referred to above quickly drop from consideration, leaving as the major item a comparison of investment required for a particular treatment against the annual operating cost. *MWP paper. No number.*

WITH READERS

Continued from page 5

passer to the chief engineer.

My personal difficulty seems to be in finding sufficient time to read all items of interest before the next month's issue hits my desk.

Vinton, Iowa GORDON RANDALL

Reader Randall touches a problem always up front in our thinking—saving time for the busy reader. Fast-moving, briefed-down writing and plenty of pictures (one is worth a thousand words) seem to be part of the answer. Any other ideas?—*Ed.*

HANDBOOK DEMAND . . .

Congratulations on your excellent POWER *Handbook! I have passed our copy of Part I around to our mechanical and electrical maintenance supervisors and mechanics and, with one accord, they have asked how they might acquire copies. Should it not be possible to obtain many copies, the supervisors asked if it might be possible to place reference copies in their shops.*

I realize that the demand for this publication will be great, but I hope it will be possible for you to meet the demand, at least partially.

Again, congratulations on a fine publication.

Longview, Washington O W BRAKEL

Now that Part II is published, we have reprints of the entire Handbook ($1.00 each, discounts for quantities). We've made a large printing and hope to meet all demands. If we can't, we have the plates and can reprint again.—*Ed.*

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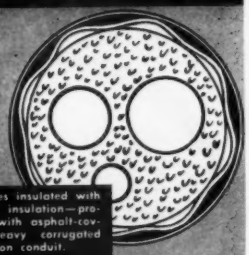

All pipes insulated with molded insulation—protected with asphalt-covered heavy corrugated ingot iron conduit.

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Sectional insulation of any specification applied to individual pipes—protected with asphalt-covered iron conduit.

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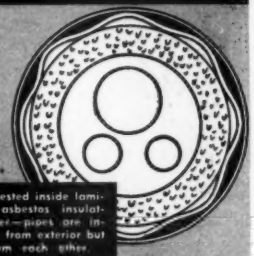

Pipes nested inside laminated asbestos insulating liner—pipes are insulated from exterior but not from each other.

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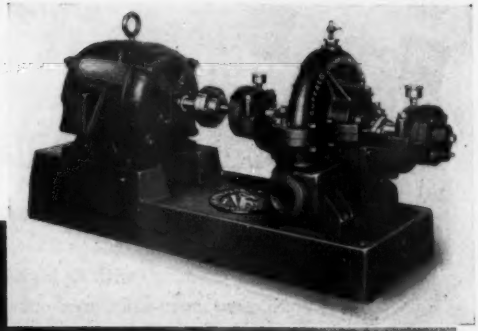
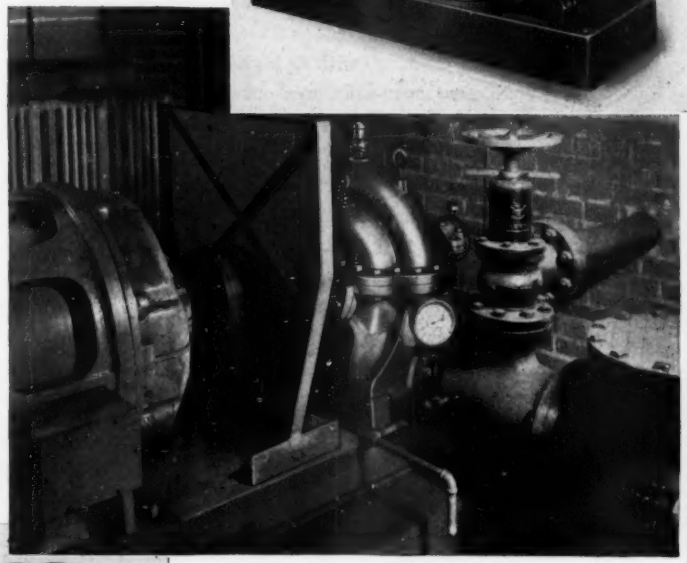
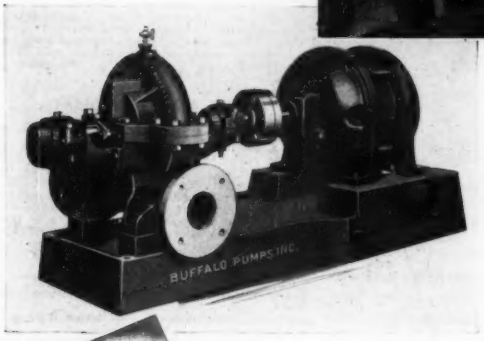




"Buffalo" "SL" PUMPS



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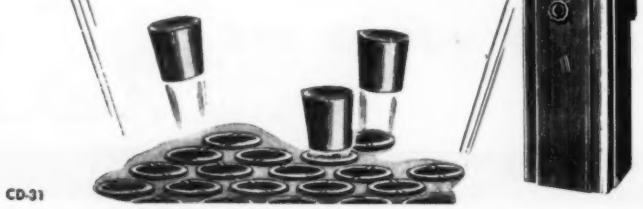


CD-31

More FREE BULLETINS

Begins on page 169

with the Model E-Z Butler de-scaler. 4-page bulletin. Butler Engrg. Co, 2612 Rousseau St, New Orleans 13, La.

B30 DIESEL ENGINE PROTECTION —Data on the functioning of Butler diesel de-scalers in railroad and marine diesel or gas engines and in combination steam-diesel power plants. 6-page bulletin. Butler Engrg Co, 2612 Rousseau St, New Orleans 13, La.

MECHANICAL TRANSMISSION

B31 ROLLER BEARINGS — Illustrates and describes full line of Shafer self-aligning roller bearings, and pillow blocks, flange units, flange cartridge units, cartridge units, duplex units, etc. 56-page catalog No. 51. Shafer Bearing Corp, 801 Burlington Ave, Downers Grove, Ill.

B32 BELT CONTACT WHEEL — Data on the company's new "61" specially serrated rubber contact wheel for abrasive belt backstand applications. 4-page bulletin. Carborundum Co, P O Box 337, Niagara Falls, N. Y.

B33 SPEED REDUCERS—Gives data relating to the single-reduction series of the Dodge Torque-Arm speed reducers. Output speeds from 115 to 330 rpm — capacities to 27 hp. 12-page bulletin No. A-602. Dodge Mfg Corp, Mishawaka, Ind.

METERS AND INSTRUMENTS, ELECTRICAL

B34 THERMOCOUPLE CODES—Chart shows the applications, calibration symbols, conductors, polarity and color codes of thermocouple and extension wires. Resistance tables for these wires are shown on reverse side. Thermo Electric Co, Inc, Fair Lawn, N. J.

B35 VOLTMETERS AND AMMETERS — Describes features of Series 500 recording voltmeters and ammeters with special emphasis on the newly developed moving-iron measuring mechanism. Gives information on ranges, uses and specifications of models for permanent and portable use. 28-page bulletin. Bristol Co, Waterbury 20, Conn.

METERS AND INSTRUMENTS, MECHANICAL

B36 PROCESS CONTROL — Measurement of pH, redox and conductivity in industrial control systems is comprehensively covered. Fundamental principles of electro-chemical measurements as well as final control elements for automatic control systems are included. 24-page bulletin No. B51-2. Minneapolis-Honeywell Regulator Co, Station 40, Wayne & Windrim Aves, Philadelphia 44, Pa.

B37 TORQUEMETERS — Descriges and illustrates Baldwin SR-4 torquemeters based on measurement with special SR-4 resistance wire strain gages. 8-page bulletin No. 328. Baldwin-Lima-Hamilton Corp, Philadelphia 42, Pa.

B38 VISCOMETERS — "A Brookfield Viscosity Packet" designed to provide complete, up-to-date information on both Brookfield viscometers and the general subject of viscosity. Packet includes 8-page catalog, data sheet, price lists, and "What Users Say" brochure. Brookfield Engineering Laboratories, Inc, Stoughton, Mass.

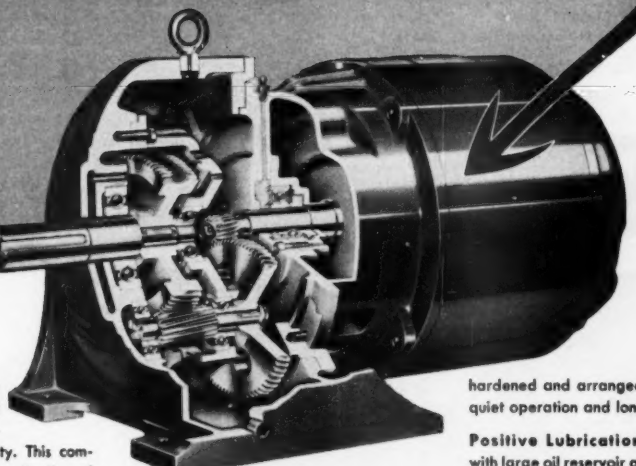
B39 TACHOMETER INDICATOR — Features the Series 42P tachometer indicator for speed measuring applications where a particularly wide range of speed measurement is desired. 2-page data sheet No. 42P. Metron Instrument Co, 432 Lincoln St, Denver 9, Colo.

PIPING, FITTINGS, VALVES AND SPECIALTIES

B40 PIPE HANGERS — Presents a line of spring hangers of the

For SLOW SPEED Output with HIGH SPEED Motor Efficiency

PHILADELPHIA GEARMOTOR



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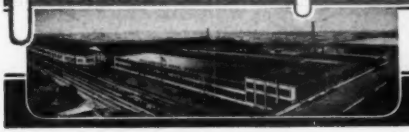

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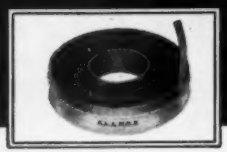

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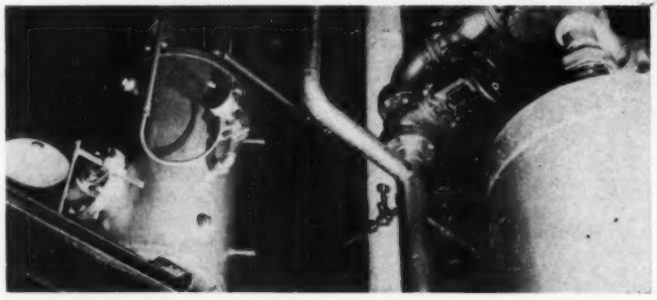

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More FREE BULLETINS

Begins on page 169

variable-support type, suitable for support of piping and allied equipment subject to positional changes resulting from thermal expansion of equipment. 12-page catalog No. 501. Bergen Gen-spring Corp, 15 Park Row, New York 7, N. Y.

B41 **RELIEF VALVES** — Gives data on 2 new multiple-assembly relief valves for large hot-water heating boiler. 2-page bulletin No. P-18. McDonnell & Miller, Inc, 3500 N Spaulding Ave, Chicago 18, Ill.

B42 **GATE AND CHECK VALVES** — Featured is a line of Ludlow valves including double disc gate valves, all-iron low-pressure gate valves, iron blast gates, swing check valves and different types of floor stands. Dimensions and list prices are included. 64-page catalog No. 202-A. Ludlow Valve Mfg Co, Inc, Adams St, Troy, N. Y.

B43 **VALVES, WATER WORKS** — Describes Ludlow valves and fire hydrants for water works service. Diagram, sizes and prices are given. 32-page catalog No. 201-C. Ludlow Valve Mfg Co, Inc, Adams St, Troy, N. Y.

B44 **NOZZLES AND FLANGES** — Describes and illustrates Taylor forge nozzles, welding necks and large diameter flanges. A 38-page company publication, "Modern Flange Design," is incorporated as a part of this 72-page catalog, No. 501. Taylor Forge & Pipe Works, P O Box 485, Chicago 90, Ill.

B45 **VALVES, HEAVY LIQUIDS** — Data on Rollo valves for viscous liquids and liquids with solids. 4-page bulletin No. W-404-B4. Worthington Pump & Machinery Corp, Harrison, N. J.

B46 **VALVE CATALOG** — Covers the company's complete line of valves. Sectional views, installation data, and diagrams are given. 44-page catalog. Ross Operating Valve Co, 120 E Golden Gate, Detroit 3, Mich.

B47 **PREFABRICATED PIPING** — Discusses advances made in field of high- and low-pressure piping subassemblies. Describes facilities for fabricating jobs from carbon steel, carbon moly, all alloys and stainless steel piping. 8-page bulletin. Western Piping Supply Div, Lummus Co, 504 W 145th St, East Chicago, Ind.

★ **SAFETY HEAD** — Presents numerous charts and tables covering almost any phase of safety head information. Fully illustrated with cutaway drawings and typical installation photos. 52-page catalog No. 54. Black, Sivalls & Bryson, Inc, 7500 E 12th St, Kansas City 3, Mo. (•Write direct to manufacturer on company stationery giving name and title.)

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B48 **JACKET WATER COOLERS** — Tells how unit heaters use waste heat recovered from engine and compressor jacket water to reduce plant heating costs. Shows how to select correct size and type of unit heaters and gives typical example illustrating calculations. 4-page bulletin. Modine Mfg Co, Racine, Wis.

B49 **JACKET WATER COOLERS** — Jacket water coolers for gas, gasoline, diesel engine and fluid cooling are described. Illustrates new design features and accessories. 4-page catalog No. 1351. Young Radiator Co, Racine, Wis.

WATER TREATMENT

B50 **WATER SOFTENERS** — Heavy-duty series water softeners, capacities up to 600,000 grs single unit — 1,200,000 grs twin unit. Pipe size up to 2-in. — tank diameter 20-, 24-, 30- and 36-in. Features, operation, specifications given. 4-page bulletin No.

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BOILER FEED PUMPS

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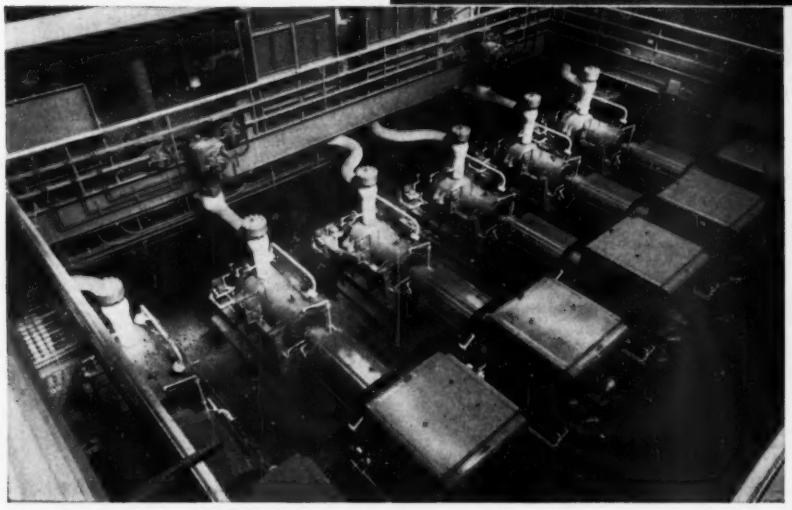

Above, Type VS, Class 6 Gýrol Fluid Drives for boiler feed pumps in process of assembly. The narrow range of speed over which a boiler feed pump must operate requires very accurate control. This is assured by thorough testing and inspection at each stage of construction.

←Left, here are 6 of 12 boiler feed pumps equipped with American Blower Gýrol Fluid Drives installed in the new, modern Sewaren Generating Station of the Public Service Electric and Gas Company. Each unit has a capacity of 2000 h.p. at 3465 rpm.

For the heavy duty required of high speed boiler feed pump drives, American Blower Type VS, Class 6 Gýrol Fluid Drives offer such important advantages to power plant operators as — power savings, flexibility of control, lower pressures and reduced maintenance.

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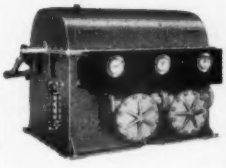

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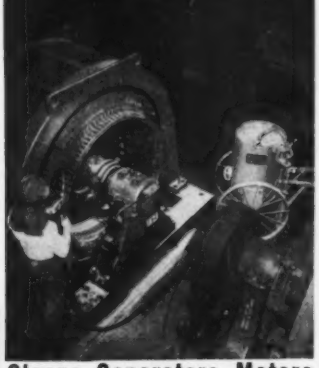
PANGBORN AC-4

"CORN COB" Blast Machine



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Faster Better Cheaper

Eliminates Toxic Hazard of Solvents!

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Look at the savings shown by this recent test on electric motors. (Name of Company on request.)

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	Material	Labor
Solvent Method	$55.00	120 hrs.
PANGBORN Method	5.00	40 hrs.
SAVING	50.00 (90.9%)	80 hrs. (66.7%)

Remarks: With Solvent, drying period took an additional 8 hours.

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New Pangborn AC-4 Blast Machines use standard 40-pound air supply to remove oil and greases with blast of soft, 20-mesh corncob grits. No residue left on parts . . . no drying period.

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BLAST CLEANS CHEAPER with the right equipment for every job

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200. Bruner Corp, 2318 N 30th St, Milwaukee 45, Wis.

B51 WATER CONDITIONING — Describes Brooks services, products and methods employed in solving many water problems encountered in industries, institutions and governmental works. 16-page bulletin No. 501. Brooks Chemicals, Inc, 3304 E 87th St, Cleveland 27, Ohio.

OTHER EQUIPMENT

B52 POWER FACTOR VISUALIZER — Prepared in the form of a slide-rule-type chart, a power factor visualizer is offered that presents a simple explanation of the use of capacitors in solving low power factor problems. Visualizer No. SA-6739. Westing house Electric Corp, Box 2099, Pittsburgh 30, Pa.

B53 SPRAY NOZZLES — Gives details covering Yarway involute nozzles for spray cooling ponds and smaller involute and flat-spray nozzles for industrial processes. 20-page bulletin No. N-617. Yarnall-Waring Co, Mermaid Lane, Philadelphia 18, Pa.

B54 AIR COMPRESSOR — Covers the Blue Brute 160' portable air compressor. Includes features, specifications and mountings. 6-page bulletin No. H-850-B73. Worthington Pump & Machinery Corp, Adv Extension, Dunellen, N. J.

B55 HEAT TRANSFER SURFACES —Illustrates wide variety of specialized heat transfer surfaces applicable to such equipment as solvent recovery, intercooling, regeneration, gas separation and liquefaction, heat economizing and drying. 4-page bulletin No. ID-151. Modine Mfg Co, Racine, Wis.

B56 CIRCULATING PUMPS — Data on Mixflo pumps for irrigation, drainage, sewage disposal, condenser circulating and low head water supply. Includes line drawings and dimensions of 5 types in sizes 20 to 84. 4-page bulletin No. W-313-BIB. Worthington Pump & Machinery Corp, Harrison, N. J.

B57 WELDING DESIGN — New edition of "Manual of Welding Engineering & Design" now includes articles on joint preparation by electric arc, additional design information, comparative data, new welding developments and chemical welding aids, procedural information. 50 pages. Eutectic Welding Alloys Corp, Dept P, 40-40 172nd St, Flushing, N. Y.

Release Japan's Gas-Synthesis Studies

Japan engaged in research on the production of synthetic liquid fuels from coal with an intensity exceeded only by Germany during the years before World War II. Unlike Germany, Japan never succeeded in obtaining a substantial part of its oil supply from this source.

The Fischer Tropsch or gas-synthesis process provided 149,250 of the 1,055,000 barrels of synthetic liquid fuels produced in Japan in 1944, the year of peak production. In that year, the Japanese also produced 5780 barrels by direct hydrogenation of coal, and 899,970 barrels by low-temperature carbonization.

A full report entitled Information Circular 7594, "The Synthesis of Hydrocarbons (Report of the Imperial Fuel Research Institute of Japan)" can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes St, Pittsburgh 13, Pa.

NOMOGRAPHIC CHARTS

Just Published!

1. A collection of 92 time-saving charts for simplifying and speeding up engineering computations. The charts apply to mathematics and general engineering, the fields of hydraulics, mechanics, and thermodynamics, and electrical problems. They are accurate in a range between slide-rule computations and exact numerical computations, and each is followed by explanatory text. **By C. Albert Kulmann. 244 pages, $6.50**

INTRODUCTION TO HEAT TRANSFER

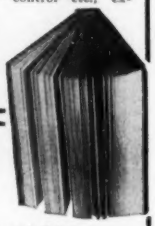
Just Published—2nd Edition

2. Shows how to solve heat transfer problems in the design of chemical engineering power, heating, and air conditioning equipment. Covers heat transfer fundamentals, applying calculations to design of heaters, condensers, boilers, combustion engine cylinders, and fan coils. Takes up radiation—forced convection—heat transfer to boiling liquids—condensing vapors—variable heat flow, etc. **By Aubrey I. Brown, Chm., Dept. of Mech. Eng., and Salvatore M. Marco, Prof. of Mech. Eng., The Ohio State U. 2nd Ed., 264 pages, 62 illus., $4.50**

ELECTRONIC MOTOR and WELDER CONTROLS

Just Published!

3. Gives detailed explanations of the circuit operation of the tube-operated equipment found in the two major groups of motor and resistance welding control, and pin points each operation with clearly drawn diagrams. Takes up basic welding controls — sequence timers — synchronous timers—seam welding controls—speed control of d-c motors—the electronic amplidyne—rubber calendar control—etc., examining equipment of advanced design throughout. **By George M. Chute, Application Eng., General Electric Co., Detroit. 348 pages, 187 illus., $6.50**



INTERNAL COMBUSTION ENGINES

Just Published—6th Edition

4. A thorough treatment of internal combustion theory, analysis, problems, and design. Discusses the combustion process, fuels, carburetion and fuel injection, combustion chamber design, engine lubrication, and engine design. **By Lester C. Lichty, Prof. of Mech. Eng., Yale U. 6th Ed. 596 pages, 461 illus., $7.00**

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SPECIFY ERNST WATER COLUMNS • LIQUID LEVEL GAGES

Bronze, Forged Steel, Stainless Steel, All Iron • For All Pressures and Temperatures • For Boilers, Tanks, Refinery Service, Etc.

Fig. 5

Standard vertical bronze water gage, 350 pound design, heavier construction up to 450 lbs. Stainless and forged steel for higher pressures.

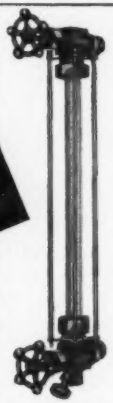


Fig. 8

All iron gages for pressure up to 250 lbs., heavier construction up to 350 lbs.

Fig. 8SS—Same fittings made in stainless steel.

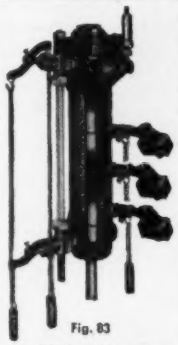


Fig. 83

No. 5 high and low alarm column with vertical gages and DCP weighted type try cocks.

Wire or Phone Ernst

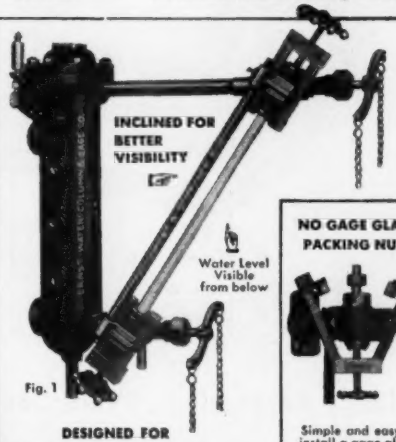


Fig. 1

DESIGNED FOR 250-450-650 LBS. W.S.P.

High and Low Alarm Column Equipped with Split-Gland Type Adjustable Inclined Water Gage

NO GAGE GLASS PACKING NUTS

Simple and easy to install a gage glass. No wrenches or tools required. A turn of the hand wheel compresses the packing.

Insure Safety with ERNST INSERTS

Mica-protected Flat Glass and PRISMATIC REFLEX

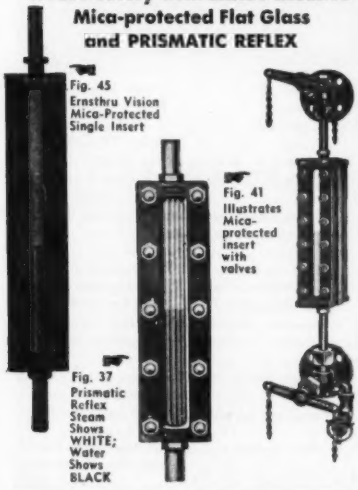


Fig. 45 Ernsthru Vision Mica-Protected Single Insert

Fig. 41 Illustrates Mica-protected insert with valves

Fig. 37 Prismatic Reflex Steam Shows WHITE; Water Shows BLACK

Fig. 10 Plain Sight Illuminator

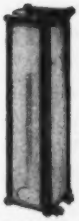


Fig. 31 Ernst Plastic Guard, Replaceable Plates

ERNST LEAKLESS TRY COCKS

Designed for 450-650-1500-2500 lbs.

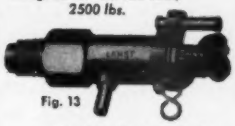


Fig. 13

Ernst Leakless Try Cocks Assure Maximum Safety

Fig. 06 Bronze, with Wheel

Weighted Type Try Cock

Fig. 15

250 lb. Pressure, Bronze, with Iron Weight Double Chain Pull

Spring Type Fig. AS-250

SIGHT FLOW INDICATORS for insertion into pipelines

"See what's going on" . . . inside

Fig. 17-28 Tubular Glass Type

Fig. E-811 Flapper Type Single Window

Write Ernst

Fig. E-57 Bulls Eye Type Double Window

GAGE GLASSES—Tubular and Flat Type

ALSO LUBRICATOR, SQUARES AND CIRCLES TO SPECIFICATIONS

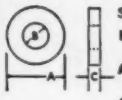
FLAT TYPE REFLEX AND CLEAR

CLEAR AND RED-LINE MAGNIFYING TYPE

WHAT YOU NEED, YOU PAY FOR, WHETHER YOU BUY IT OR NOT

High Pressure Composition RUBBER GASKETS

Manufactured in all sizes to fit your water gages



Specify:

B—Inside Diameter

A—Outside Diameter

C—Thickness

Fig. 21—Lip Mold Rubber Gasket

Fig. 22—Standard Rubber Gasket

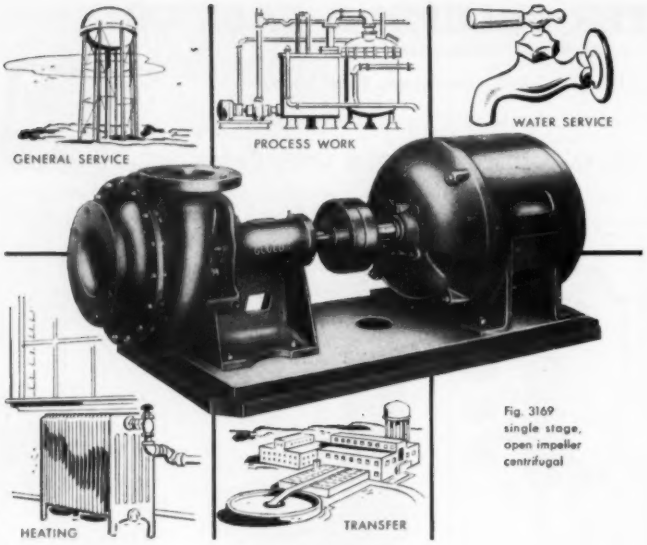


Fig. 3169 single stage, open impeller centrifugal

Highly Adaptable . . . Exceptionally Efficient

NEW GOULDS PUMP

Designed for Long Service

Here's a new Goulds pump, built to do many different jobs. Especially designed for general water service, process work, slurries, circulation, transfer, and factory wastes, the remarkably versatile 3169 also handles air conditioning, plumbing, heating, and many others.

DEPENDABLE, ECONOMICAL OPERATION Its modern hydraulic design provides exceptionally high operating efficiency with low power consumption. Ruggedly constructed, yet light and compact, this pump will give you trouble-free service over the long pull.

AVAILABLE IN TEN SIZES Available in ten sizes for both motor and belt drives, the 3169 has capacities up to 1080 G.P.M.—with heads to 290 ft.

For complete information phone or write Pump Headquarters, Seneca Falls, N. Y. Ask for Bulletin 720.4.

MEMBER

Goulds PUMPS INC. Seneca Falls New York

APPOINTMENTS

Allis-Chalmers Mfg Co, Milwaukee, announces re-election of W A Roberts as president, and election of Boyd S Oberlink as vice-president. Oberlink will continue to serve as assistant to the vice-president in charge of tractor div. . . . J F Roberts becomes director of engineering and R C Allen consulting engineer of general machinery div. . . . W A Yost is named head of newly organized mechanical power dept. Reporting to Yost are: O A Haas, manager of blower and condenser section; T J Hodan, manager of water conditioning section; C C Jordan, manager of steam turbine section; and W J Rheingans, manager of hydraulics section. . . . Thomas J Hanley succeeds the late D J Goodsole as supervisor of electrical and hydraulic turbine service and erection.

New distributor in the Chicago area for **Cyclotherm Corp** is Temperature Equip Corp, 816 N Kostner St, Chicago.

Combustion Control Corp, Cambridge, Mass., appoints Laurence D Sibley vice-president in charge of sales.

William S DuBois has been named to head a new department of market research established by **Harbison-Walker Refractories Co,** Pittsburgh. . . . Lawrence E Mock has succeeded W Forman Bickel who resigned as treasurer after having served in this capacity for 24 years. Bickel will continue to serve as a director.

Westinghouse Electric Corp assigns T I Phillips to the staff of industrial products vice-president John K Hodnette. Thomas R Lawson becomes assistant sales manager and Mark F Slusser administrative assistant, industrial product sales. . . . Robert E Ferry is named manager of apparatus sales offices in Wheeling and Fairmont, W. Va. He will be located in the National Bank of West Virginia Bldg, Wheeling. . . . L B McCully is made general manager of East Pittsburgh divisions in addition to his present duties as manager of transportation and generator divisions. . . . New Northwestern district headquarters are now located in the Merchandise Mart, Chicago.

Leo J Haller has been appointed sales engineer in the Pitttsburgh branch office of **Builders Iron Foundry** and its associates, Builders-Providence Inc, Omega Machine Co, and Proportioneers Inc.

Hays Corp, Michigan City, Ind., promotes John R Heming to position of project engineer in charge of combustion control.

Boston office of **Leeds & Northrup Co** has moved to 430 Lexington Ave, Auburndale (Boston).

Harmon E Keyes, chemical and metallurgical engineer, has joined the technical staff of **Infilco Inc,** Tucson, Ariz., as a special consultant.

D J Murray Mfg Co, Wausau, Wis., announces re-election of Fred C Boyce as president. Other elections include: A W

WeldELLS®

...There are no fittings like WeldELLS

When we say there are no welding fittings like WeldELLS we feel that we are simply repeating the expressed opinions of thousands who know pipe welding.

Often it is the opinion of a designer who recognizes the engineered strength distribution and closely controlled metallurgy of these fittings that are designed by engineers.

Frequently, it is the opinion of a construction superintendent, maintenance man, or welding foreman who has discovered job-speeding, cost cutting features in WeldELLS that are combined in no other fittings.

Sometimes it is the opinion of those whose unusual requirements can only be satisfied in the broader Taylor Forge line; for in certain sizes, weights and materials it can be truthfully said that *there are no fittings* BUT *WeldELLS!*

TAYLOR FORGE & PIPE WORKS
P. O. Box 485, Chicago 90, Illinois
Offices in all principal cities
Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada

Taylor Spiral Pipe is available in a broader range of sizes and thicknesses. Coupon brings pipe bulletin.

☐ Please send Catalog 484 covering welding fittings and forged steel flanges.

☐ Send Bulletin 493 covering Taylor Spiral Pipe and related fittings.

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POSITION _____

COMPANY _____

STREET ADDRESS _____

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Mail to Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Ill.

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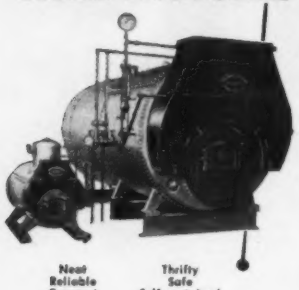
TAYLOR FORGE

LEFFEL
SCOTCH TYPE BOILERS



Neat Reliable Compact — Thrifty Safe Self-contained

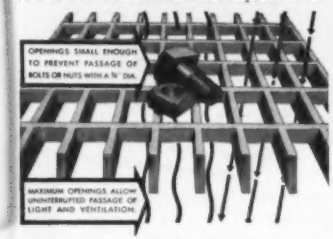
Leffel offers you the exact boiler to suit your plant need. Available in conservative ratings of 6 through 250 *actual* horsepower, Leffel boilers are built to take substantial overloads. And the savings on fuel will amaze you. Where boiler room space is at a premium, a compact Leffel is the answer. COAL, GAS or OIL fired; easy to convert from one type of fuel to another. (For stoker firing, the specially designed Leffel Underfeed Stoker may be used). Before you buy a boiler, it will pay you to get the facts on the line of Leffel Scotch Type Boilers.

Write for descriptive catalog.

The James Leffel & Co.
ESTABLISHED 1862

Dept. O — Springfield, Ohio

TRI-LOK RECTANGULAR OPEN STEEL FLOORING


OPENINGS SMALL ENOUGH TO PREVENT PASSAGE OF BOLTS OR NUTS WITH A ½" DIA.
MAXIMUM OPENINGS ALLOW UNINTERRUPTED PASSAGE OF LIGHT AND VENTILATION

Tri-Lok strength is obtained by truss action through twisted cross-bar, curved in opposite directions at each bearing-bar. Standard openings in Tri-Lok Rectangular Steel Flooring are 1" x 3 7/16"—other sizes can be supplied as required.

Diagonal, or Super-Safety U-type Flooring, and stair treads of all types, are available. Bulletin KF 1140 describes the construction features of Tri-Lok Open Steel Flooring.

The Tri-Lok Company is also equipped to furnish *riveted* and Tri-Forge *welded* open steel flooring. Tri-Lok grating can be furnished in a variety of metals, including aluminum alloy, stainless steel, etc.

DRAVO CORPORATION
National Distributor for the
Tri-Lok Company
Dravo Bldg., Pittsburgh 22, Pa.
Sales Representatives
in Principal Cities

DRAVO

More APPOINTMENTS

Begins on page 220

Plier, executive vice-president and general manager; M P McCullough and D C Everest, vice-presidents; C L Durkee, vice-president and sales manager; George I. Ruder, treasurer; W A Marquardt, secretary.

Robert W Suman has been made chief engineer of **Link-Belt Co's** Philadelphia plant. He has replaced William S Campbell who retired from active duty.

General Electric Co announces personnel changes as follows: Laurence R Lee is now assistant to manager of engineering for turbine divisions. C B Seelig is appointed assistant manager of Fitchburg (Mass.) turbines sales div. . . . Dr Louis T Rader becomes assistant manager of engineering of control divisions at Schenectady, N. Y. . . . Gordon E Walter is named assistant division engineer of specialty transformer engineering div at Fort Wayne, Ind. . . . E E Hinson as assigned as sales representative in Washington, D. C. He will be located at 805 15th St, N W, and will have responsibility for the sale of industrial laminated plastics and electric insulating materials. . . . John F Welch succeeds Enno W Lankenau who retired as manager of fractional horsepower motor divisions plant in Decatur, Ill.

William C Young, sales engineer with **Nordberg Mfg Co,** is transferred to the firm's office in Washington, D. C. Joseph Monroe will assume Young's duties as sales engineer in the Milwaukee office.

Gulf States Insulation Co, P O Box 1281, Mobile, Ala., has been chosen distributor for **Plibrico Jointless Firebrick Co.**

Owens-Illinois Glass Co assigns Frank A Davenport as Kaylo sales engineer in Atlanta, Ga. He replaces C H Ramien who is now acting as resident engineer at a Kaylo installation for Gulf Oil at Port Arthur, Texas.

A P Jeffery has become a power plant equipment sales engineer for **Swartwout Co** in the Albany and Schenectady territory. He will be located at 11 Dutch Village, Albany, N. Y.

Albert B Diss is now manager of manufacturing operations of **Watson-Stillman Co,** Roselle, N. J.

Chicago midwest headquarters for **Sarco** sales representatives has been moved to 322 W Randolph St, Chicago.

Aetna Ball & Roller Bearing Co, Chicago, elects J J Rozner vice-president in charge of operations. J E Dillon replaces Rozner as chief engineer. C E Poehler becomes assistant to plant superintendent.

John H Mackey has succeeded Roy H Nelson as assistant superintendent of Brier Hill blast furnaces of **Youngstown Sheet & Tube Co.** Nelson has recently been made

ENSIGN
Centrifugal Switch

Watchdog of your Conveyor System

Interlocking of Belts

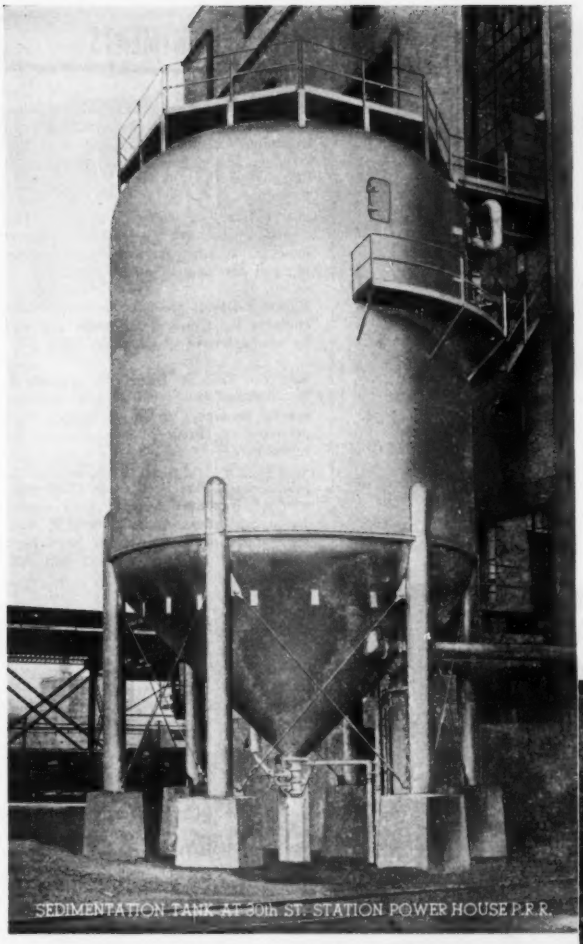
The Ensign Centrifugal Switch provides for the sequence operation of multiple belts. As the belt on which the switch is installed reaches the required speed the control circuit of the starter on the inby belt is closed.

Belt Protection

When used with time delay relay the Ensign Centrifugal Switch prevents burning of belt due to slippage.

Available for A.C. or D.C. current. Write for Bulletin No. 1100.

ENSIGN
ELECTRIC AND MANUFACTURING CO.



SEDIMENTATION TANK AT 30th ST. STATION POWER HOUSE P.R.R.

COCHRANE

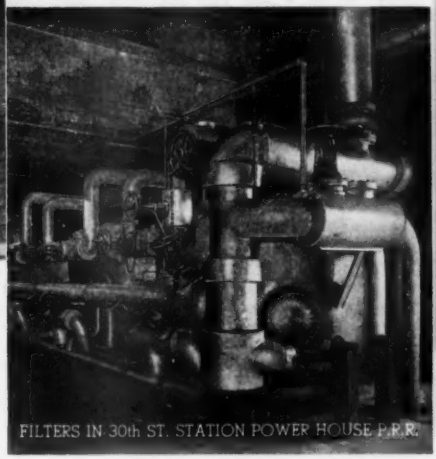
Hot Process SOFTENER

Serves a Great Railroad

ONE of the features of the huge Pennsylvania Station—30th Street, Philadelphia, of the Pennsylvania Railroad is the ultra modern power plant designed by internationally recognized architects and engineers. Recently installed in this power plant to serve additional capacity is a Cochrane two-stage Hot Process Softener for the boiler feed. It will handle 80,000 gallons per hour makeup and 10,000 gallons per hour condensate. The first stage of softening is lime and soda ash, the second stage is phosphate treatment. The water is then filtered.

Cochrane developed the hot process of softening boiler feed many years ago and has continued its leadership in the water treatment field.

Consult Cochrane on any problem involving water conditioning.



FILTERS IN 30th ST. STATION POWER HOUSE P.R.R.

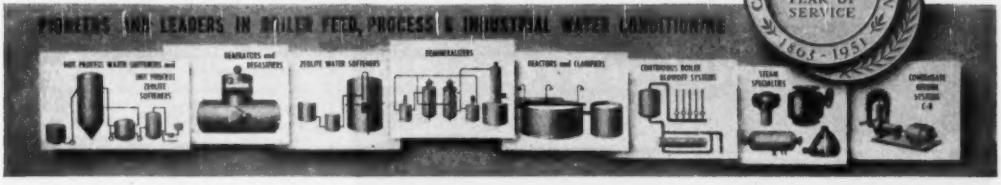
COCHRANE CORPORATION
3106 N. 17th Street
PHILADELPHIA 32 PENNA.

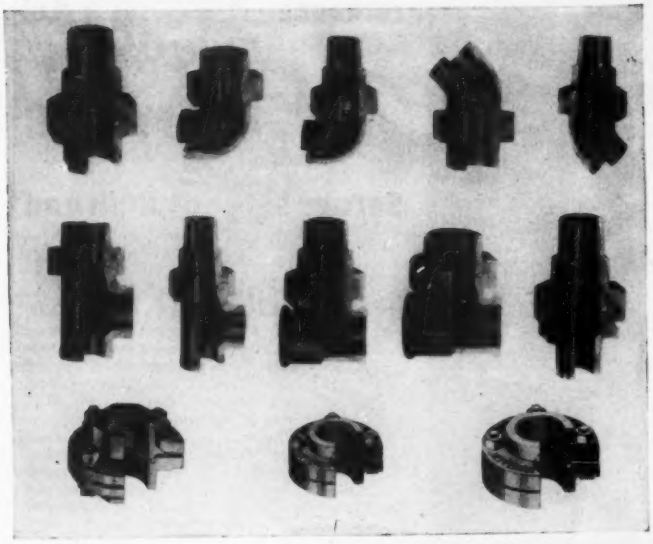
In Canada
CANADIAN GENERAL ELECTRIC CO., LTD. TORONTO

In Mexico
BABCOCK & WILCOX de MEXICO, S. A. MEXICO CITY

In Europe
RECUPERATION THERMIQUE & EPURATION PARIS

COCHRANE





Jefferson

AIR REFINED, AIR-TESTED MALLEABLE IRON

UNIONS

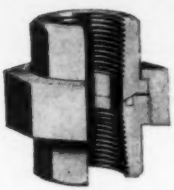
. . . featuring the RECESSED BRASS SEAT

. . . for permanent tightness without jamming

All Jefferson Unions including Specialty Types feature the Recessed *spherically ground* Brass Seat . . . a construction which assures a leakproof union rather than a jam joint. Furthermore, this design provides a brass to iron joint with the seat so located as to be fully protected from pipe ends should they be screwed in too far. Rings are cut from special brass tubing . . . not cast, and ring channels are machined rather than cast. These details insure against any possibility of the seat rocking.

In addition to its regular line of unions, Jefferson also makes AAR male and female unions, Enduro 300#, Excel 250# and Master 150# unions.

All Jefferson Unions in all types can also be furnished with ground, all-iron seats.



Get full details from your nearest distributor . . . or write us direct.

Jefferson UNION CO.

605 W. 26th St., New York 1, N. Y.

63 Gooding St., Lockport, N. Y.

39 Fletcher Ave., Lexington 73, Mass.

More APPOINTMENTS

Begins on page 220

assistant superintendent of Hubbard blast blast furnace. . . . Frank Senzik has been appointed assistant superintendent of construction for the Youngstown, Ohio district of the firm.

Binks Mfg Co, Chicago, announces addition of a pump div. Karl W Osterstrom is made manager in charge of sales, engineering and development of this division.

Robert L Day is promoted to factory sales engineer for **General Controls** and will be headquartered at Glendale, Calif.

Key Co, East St. Louis, Ill., appoints L W Matthey vice-president and assistant general manager; and F B Riggan, vice-president in charge of research and development.

John Seagren has been made chief engineer of **National Supply Co's** engine div at Springfield, Ohio. Harvey W Hanners and George F Noltein have been named chief research engineer and consulting engineer, respectively.

Chas J Riley & Sons, Chicago, specialists in conservation of tanks, bunkers, and other surfaces, announce the extension of this service to the East through their association with W J O'Brien of **O'Brien Steam Specialty Co,** 393 Heffernan Bldg, Syracuse, N. Y.

Gordon Miscall has joined **Parker Appliance Co,** Cleveland, as industrial sales engineer. He will represent the firm in the southern Ohio, western Pennsylvania, West Virginia and Kentucky territory. Miscall succeeds H C Jacobs, now representing the company in northern Ohio and Indiana, an area previously served by C D Uldricks, presently Pacific Coast representative with headquarters in Los Angeles.

Richardson-Allen Corp, New York, names Dr Harry N Walker vice-president in charge of sales.

Edgar H Cummings becomes chief engineer of the **Round Associate Chain Companies.**

Skilsaw Inc, Chicago, announces election of Edwin B McConville as executive vice-president; Paul Watts, vice-president in charge of sales; and Ralph B Brundrett, treasurer.

David E Feinberg has been made a vice-president of **United States Air Conditioning Corp,** Minneapolis.

Westinghouse Air Brake Co has established sales facilities in Canada. Canadian Westinghouse Co, Ltd, Hamilton, Ontario, will handle the firm's line of industrial air compressors and pneumatic control equipment.

Henry Steffans is made manager of **Thomas C Wilson's** new office at 3147

Republic Tips

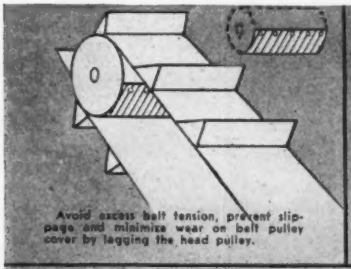
TO ELEVATOR BELT USERS

● With Republic Elevator Belting on the job, you're set to handle bigger pay loads with less trouble

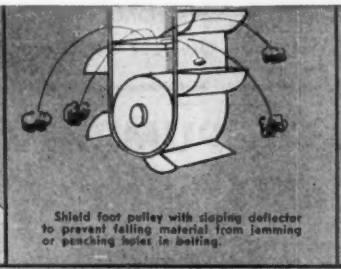
Don't lose this advantage by improper methods of application and maintenance!

Your local Republic Rubber Distributor can show you many ways to improve efficiency and increase service life of elevator belts. As an experienced specialist, he is fully prepared to help you select exactly the right Industrial Rubber Product for your requirement. Contact him today

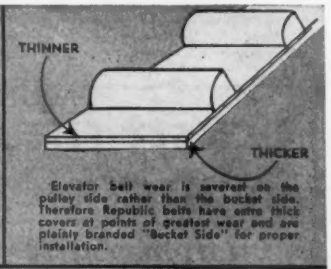
Remember, Republic Rubber has been *the* specialist in the field of Industrial Rubber Products for more than 50 years. Use Republic products and you use the best. Use Republic products *correctly* and you save the most!



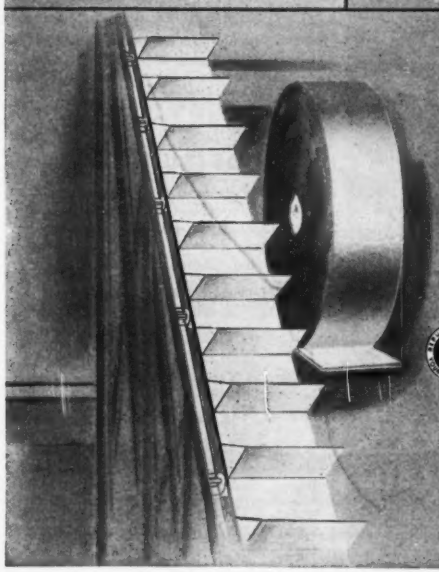
Avoid excess belt tension, prevent slippage and minimize wear on belt pulley cover by lagging the head pulley.



Shield foot pulley with sloping deflector to prevent falling material from jamming or punching holes in belting.



Elevator belt wear is severest on the pulley side rather than the bucket side. Therefore Republic belts have extra thick covers at points of greatest wear and are plainly branded "Bucket Side" for proper installation.



stop costly breakdowns with REPUBLIC ELEVATOR BELTING!

Republic Elevator Belting is built to keep moving under the most grueling working conditions.

Made in fold-edge construction with multiple plies of heavy, prestretched rubber-insulated fabric, Republic Elevator Belting is specially designed to resist bolt pull at the buckets.

Tough abrasion-resistant black rubber covers give belt carcasses maximum protection . . . stand up longer under more severe service requirements.

Republic Elevator Belting is supplied in all standard widths and plies. All fabrics are permanently treated against mildew.

See your local Republic Distributor or write direct for full facts.

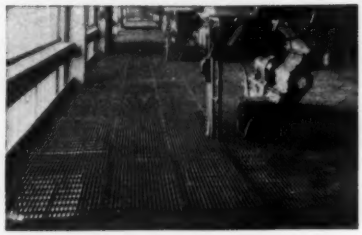
INDUSTRIAL RUBBER PRODUCTS BY

REPUBLIC RUBBER DIVISION

Lee Rubber & Tire Corporation

YOUNGSTOWN, OHIO

Hendrick Open Steel Flooring



has rectangular, square-edge steel bars that provide a non-slipping, level walking surface . . . 90% open area for light and ventilation . . . great strength to support heavy loading, without any lateral deflection of bars . . . no bolts, rivets or angle irons to loosen, or to collect dirt and refuse . . . no welds, with residual stresses that lead to warping.

Hendrick Mitco Open Steel Flooring is regularly furnished in integral panels up to 38 inches wide, with lengths to suit span.

1876—Seventy-Fifth Anniversary—1951

SEE OUR CATALOG IN SWEET'S

HENDRICK

Manufacturing Company

46 DUNDAFF STREET, CARBONDALE, PENNA.

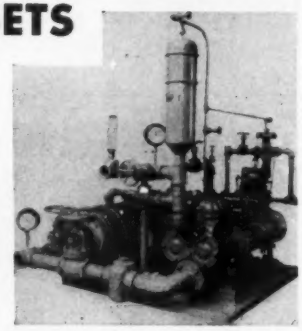
Sales Offices In Principal Cities

Perforated Metals
Perforated Metal Screens
Wedge-Slot Screens
Architectural Grilles
Mitco Open Steel Flooring,
Shur-Site Treads, Armorgrids

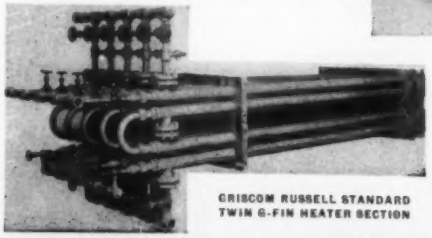
LOCKETT FUEL OIL PUMPING and HEATING SETS

Custom Built

For almost a half century, Lockett has been supplying, to fit individual needs, efficient, standard and custom-built, Fuel Oil Pumping and Heating Sets, for mechanical and steam atomizing oil burners. Combinations of various types of pumps are available. Each pump is suitable for the full rated capacity of the unit; and one heater section is a spare. Lockett supplies everything, complete. Inquiries are invited. *Ask for Bulletin AML-40-2.*



The efficient, compact unit illustrated above, consists of one Worthington Duplex Steam Pump and one Electric-driven Pump.



GRISCOM RUSSELL STANDARD TWIN G-FIN HEATER SECTION

Heaters for Lockett Pumping and Heating Sets consist of the proper number of G-Fin Sections mounted in parallel, or series, with one unit as a spare. *Ask for Bulletin AML-40-4.*

A. M. LOCKETT & COMPANY, LTD.

Contracting Mechanical Engineers

NEW ORLEANS - HOUSTON - DALLAS - GALVESTON

More APPOINTMENTS

Begins on page 220

N Broad St, Philadelphia. This office will serve the Philadelphia, Camden and Trenton areas.

Weston Electrical Instrument Corp, Newark, N. J., announces retirement of Harold L Olesen, executive assistant, after 20 years of service.

Yale & Towne Mfg Co, Philadelphia Div, has sold its industrial scale business to Detecto Scales Inc, Brooklyn, N. Y. The transaction involved scale patents, equipment, parts and inventory, but none of the Yale trade marks, except "Kron."

Fluor Corp, Ltd, Los Angeles constructors and engineers, appoints Robert L Merrick manager of engineering and construction. John Marshall becomes manager of engineering, while Frank G Crawford assumes duties of chief engineer — mechanical.

Brig Gen Paul X English (ret) has joined **Guy B Panero,** engineers of New York and Washington, as director of industrial engineering.

Frank P Anderson is appointed secretary of Hydraulic Institute, the Compressed Air and Gas Institute, the Heat Exchange Institute and the Diamond Core Drill Mfrs Assn. Headquarters of the various groups are at 122 E 42nd St, New York City.

Refrigeration Equip Mfrs Assn announces election of officers as follows: W A Siegfried, president, Superior Valve & Fittings Co, succeeds R H Israel—president; R L Sears, director of sales, Lynch Corp,—vice-president; John E Dube, president, Alco Valve Co,—treasurer; and L C McKesson, vice-president in charge of sales, Ansul Chemical Co,—secretary. These new officers, with R H Israel, retiring president, comprise the executive committee of REMA for the fiscal year as of May 1.

OBITUARIES

Ward S Patterson, 46, executive assistant to the vice-president in charge of engineering, Combustion Engrg-Superheater Inc, New York, died May 21 at the Northern Westchester Hospital, Mt. Kisco, N. Y.

T M Heermans, 62, assistant manager of sales of Allis-Chalmers centrifugal pump dept, died suddenly May 17 in Milwaukee, Wis.

James M Kenny, 48, a contract engineer for Combustion Engrg-Superheater Inc, died on May 12.

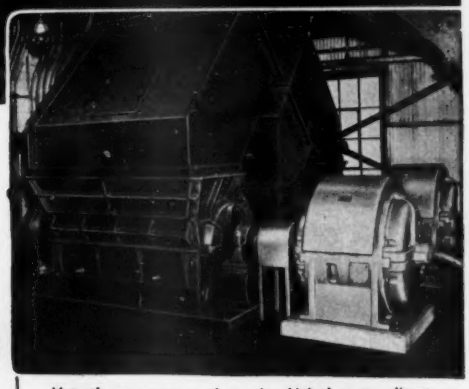
William N Brownlie, plant superintendent at the Massachusetts Memorial Hospital, Boston, died May 19 in that city.

Ralph A Gerow, 55, chief engineer at the Massachusetts Reformatory, West Concord, Mass., died May 12 in that town.

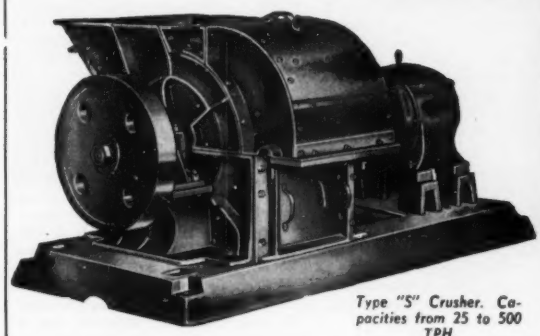
TWIN AMERICAN CRUSHERS PRODUCE 3,570,000 TONS OF CRUSHED COAL IN 5½ YEARS

16" ROM Reduced to ¾" at 900 Tons Per Hour

The Ohio Power Company Tidd Plant at Brilliant, Ohio



Note the compactness of area in which these two direct motor-connected 60S Americans are installed



Type "S" Crusher. Capacities from 25 to 500 TPH.

In commercial service since September, 1945, at the Tidd Plant of The Ohio Power Company, Brilliant, Ohio, the twin American 60S Crushers shown in the installation above have reduced 3,570,000 tons of 16" run-of-mine bituminous coal to a ¾" product.

Even with this record, these crushers—each rated at 450 tons per hour—were not fully loaded until November 1, 1948, when the plant started commercial service of its second turbo-generator.

CRUSHERS NOW HANDLING 420,000 TONS PER UNIT PER YEAR

Close to half a million tons per unit . . . the dependable, uniform, high tonnage at The Ohio Power Company plant is typical of American performance. Rugged Americans are producing unfailingly at other plants throughout the world, too—offering a *complete* once-through crushing plant in *one compact unit.*

Get the full details on efficient power plant coal reduction.
WRITE for Builetin "CRUSHING COAL AT LESS THAN 1¢ PER TON"

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

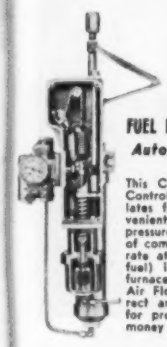
1349 Macklind Ave.
St. Louis 10, Mo.

PUT YOUR FUELS TO WORK WITH

PEAK EFFECTIVENESS..

SEND FOR Bulletin 300

CASH STANDARD
AUTOMATIC COMBUSTION CONTROL SYSTEMS



CASH STANDARD FUEL FEED CONTROLLER . . .

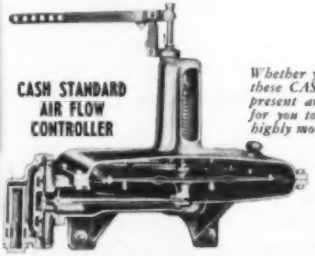
Automatically Regulates Fuel Feed

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

Your boiler room is a number ONE place to make cost cuts through gaining peak effectiveness of your fuels, You accomplish this through the installation of a CASH STANDARD Automatic Combustion Control System. Then you realize—LESS FUEL COSTS—LARGER BOILER CAPACITY — SAVINGS IN MAINTENANCE.

The reason for these benefits is that these CASH STANDARD units give you CORRECT FUEL FEED—FUEL AIR RATIO, and OVER-FIRE DRAFT.

CASH STANDARD units are available in a number of variations. Combinations can be made to give you complete automatic control with all of its benefits whether for one or a battery of boilers. Size or type of boiler makes no difference.

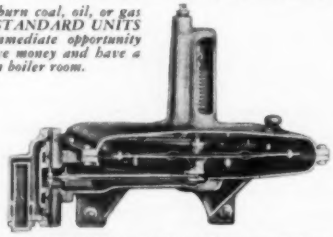


CASH STANDARD AIR FLOW CONTROLLER

Whether you burn coal, oil, or gas these CASH STANDARD UNITS present an immediate opportunity for you to save money and have a highly modern boiler room.

Meters the Air Needed for Combustion

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



CASH STANDARD FURNACE DRAFT CONTROLLER

Maintains a Constant Draft in the Combustion Chamber

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber.

CASH STANDARD CONTROLS.. VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

More POWER NEWS

Continued from page 206

Tangier Puts in Diesels for Power

To provide for municipal water supply, industrial and residential power and light for an expected 100,000 population by 1956, Tangier, North Africa has provided two Worthington 1370-hp diesel generator sets with SEH-6 engines and Electric Machinery Co generators.

Present power plant includes two Italian-made generators, one 2200 hp and the second 1700, which will work in parallel with the new Worthington units. One 1000-hp and one 500-hp engine generator will be retired.

Largest Steam Turbine on Order

Public Service Electric and Gas Co of New Jersey has placed with Westinghouse Electric Corp an order for a 185,000-kw tandem compound steam turbine, largest single-shaft 3600-rpm turbine ever built. It will have 25-in.-long blades, longest ever used.

The turbine scheduled for service at the company's Burlington plant will operate with steam at 2350 psi and 1100 F, with reheat to 1050 F. It will be a triple exhaust design. Speed at the tips of the 25-in. blades will be about 1070 mph.

Utilities Burn Record Coal Tonnage

America's electric utilities consumed nearly 92 million tons of coal in 1950 and probably will reach a record 108 million tons this year.

These figures, according to L R Ludwig, assistant to the vice-president, Westinghouse Electric Corp, place electric utilities almost on a par with the steel industry as a market for the nation's coal.

The electric-utility industry burned 9.4% more coal than in 1949 but was still about 8% below the peak year's consumption of 99½ million tons in 1948.

Westinghouse market-analysis people estimate that the total annual sales of kilowatt-hours by the electric-utility industry will rise from about 275 billion in 1950 to 634 billion in the next 15 years. Using the 1950 ratio of coal to kwhr they find the electric utilities will be using about 211 million tons annually, about 2½ times the present consumption.

Amount of coal required to generate a kwhr of electricity has declined from about 7 lb per kwhr in 1900 to the average rate in 1950 of 1.19 lb. Some of the newest steam plants are operating at a rate of ¾ lb per kwhr. Advances made in steam turbine and generator design are responsible for much of this gain in fuel-burning economy.

The steam turbines of tomorrow will be even larger and more economical. Single-shaft, 3600-rpm turbines with maximum capabilities of 125,000 kw already are under construction, and 150,000-kw machines are on order.

(*Continued on page* 230)

2 GREAT PIPE INSULATIONS

Unibestos No. 750 - to 750°F.
Unibestos No. 1200 - to 1200°F.

Available in Cylinders or Half-rounds

UNIBESTOS®

. . . single-layer application saves money

When you can insulate a pipe efficiently with only one layer of covering, you save money. The range of thicknesses in which Unibestos Pipe Insulations are made permits the economies of single-layer application. Also a distinct saving in warehousing is made possible because fewer sizes of insulation are required in stock for maintenance work. But range of insulation thicknesses for single-layer application is only one of the many features of these 2 great pipe insulations—UNIBESTOS No. 750 and No. 1200. Write today for catalog giving complete information.*

UNARCO

UNION ASBESTOS & RUBBER COMPANY

DEPT. 1819 • 332 SOUTH MICHIGAN AVENUE • CHICAGO 4, ILLINOIS

**New 8-page catalog (No. 76-109) "UNARCO Insulations • Asbestos Packings • Gaskets • Textiles"*

Discarding condensate because of OIL?

If you are throwing away valuable condensate rather than risk its return to the boiler because of oil contamination, filtration with Sorbo-Cel may be the answer to your problem.

Low in Cost

This specially processed diatomaceous silica powder provides a simple, economical method of removing emulsified oil from water and thereby obtaining an oil-free condensate for boiler feed or other use. Total cost ranges from only 1¢ to 3¢ per 1000 gallons of water filtered.

How it works

A small amount of Sorbo-Cel is simply mixed with the oil-contaminated water, which is then pumped through a pressure filter. Here the oil globules are removed by the specially treated Sorbo-Cel particles, and both are retained upon the filter screen. The filtered water alone passes through.

Does complete job

Sorbo-Cel does a complete job of oil removal. In addition, it removes other suspended matter such as rust, scale, clay and precipitates. And its action is so efficient that large volumes of water can be filtered in a relatively short time.

A bulletin that gives further facts about this low-cost way to remove oil from water is available on request. Just use the coupon below.

JM

Johns-Manville
SORBO-CEL

Johns-Manville
Box 290, New York 16, N. Y.
Send me free bulletin giving advantages of Sorbo-Cel filtration.

Name_____

Company_____

Address_____

City_____ State_____

Pow-7

More POWER NEWS

Continued from page 228

Money Sought for Packaged Power Plants

MELBOURNE (*McGraw-Hill World News*)—Recurrent power blackouts, which have been harassing Australian industrial centers for ten years, will be licked within another year in Sydney if $6 million can be found for importation of American "packaged" power plants.

Sydney is mainly interested in the 5000-kw units which were developed during World War II for rapid installation in new load centers. Plants are completely self-contained and are supplied as prefabricated units ready for installation. They need only a concrete foundation and a fibro-asbestos shed.

By midyear, Sydney's long-term power development program is expected to add 90,000 kw to present capacity. This increase will be insufficient to tide Sydney's industries over periods of high loads, but with the power from American package plants thrown in, Australia's largest industrial city hopes to pull through the next winter without blackouts.

Latest Standards Listing Released

Ninety-nine new and revised American Standards are listed for the first time in the last edition of the Price List of American Standards, just published by the American Standards Assn, 70 E. 45th St, New York, N. Y.

This list contains more than 1180 standard specifications, methods of test, and symbols and abbreviations in civil engineering and construction, mechanical engineering, electrical engineering, safety codes, ferrous and nonferrous materials and metallurgy, rubber, textiles, mining, pulp and paper, photography, motion pictures, and gas burning appliances.

Important new standards listed include a series on electric discharge lamps—general service, instant-start, single-pin, hot-cathode, cold-cathode, and bactericidal—electrical indicating instruments, gas water heaters, grounding-type attachment plug caps and receptacles, and safety requirements for operation of open-surface tanks. There are also two new American Standards on gears, one on nomenclature, terms, definitions and illustrations, and the other on inspection of fine pitch gears.

The 26-page list of American Standards (May 1951) can be obtained from the American Standards Assn, 70 E. 45th St, New York 17, N. Y. without charge.

Seventy-two sound films, covering a range of general interest subjects, produce information, training and instruction courses, are listed in a 1951 sound-film catalog available from **Westinghouse Electric Corp,** Box 2099, Pittsburgh 30, Pa.

The American Institute of Architects awarded **Anemostat Corp of America** a certificate of exceptional merit for excellence in technical and promotional literature for guidance of architects.

LAST LONGER FIT BETTER

TESTS PROVE PYREX Brand GAUGE GLASSES MOST ECONOMICAL

Proved to outlast any other gauge glass by a wide margin, PYREX brand cuts your maintenance costs to the irreducible minimum!

PYREX brand gauge glasses are highly resistant to chemical attack. They withstand severe physical and thermal shock. No other gauge glass, imported or domestic can consistently meet such tests.

Yet, PYREX glasses cost no more . . . and give longer service life. Economize today. Specify PYREX brand gauge glasses. Available through your Industrial Supply Distributor.

CORNING GLASS WORKS

CORNING, N. Y.

T.M. REG. PYREX U.S. PAT. OFF.

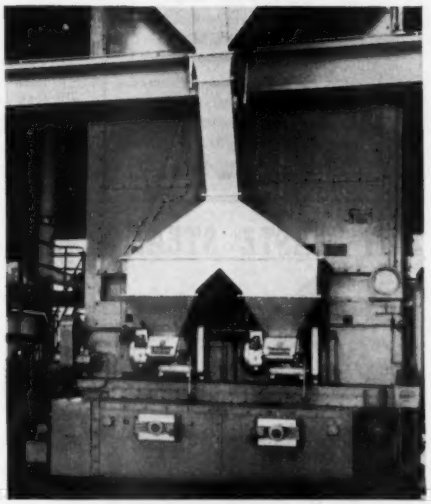
Gauge Glasses, Sight Glasses, Oil Cup and Lubricator Cup Glassware.

• 100 Years of Making Glass Better and More Useful •

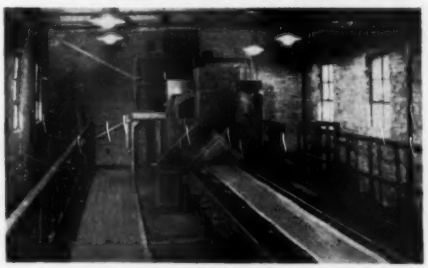
FAIRFIELD SERVING THE NATION'S POWER PLANTS

Built for END RESULTS

The true test of any coal handling system rests on its "on the job" performance record—month in and month out. Building performance and "end results" into coal handling systems requires specialized knowledge of equipment and boiler house construction. A good example of such coordinated planning and construction is shown here, at work for a large automobile manufacturer in Ohio. This Fairfield installation utilizes track hoppers, reversing flight conveyor, bucket elevator for ground storage, continuous bucket elevator, belt conveyor equipped with tripper, concentrating chutes, meters and stoker hoods. And its excellent operating history is but one example of the operating efficiency enjoyed by hundreds of Fairfield-equipped boiler houses in all parts of the country. Why not take advantage of a Fairfield recommendation on your proposed expansion or new plant facilities by writing or calling for a Fairfield Sales Engineer today.



Concentrating chute, Bailey meter and stoker hood serving one of the main boilers.



Shown above is the 112 ft. belt conveyor and self-propelled tripper for loading coal storage bunkers.

FAIRFIELD

The FAIRFIELD ENGINEERING COMPANY

335 Chicago Avenue

MARION, OHIO

"GUNITE" Concrete

(SINCE 1918)

Linings for

STEEL BUNKERS •
DUCTS, HOPPERS •
STACKS •
UPTAKES •
BREECHINGS •

• • •

STEEL & PIPE ENCASEMENT

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FIREPROOFING •

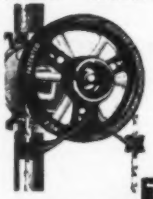
GUNITE CONCRETE & CONST. CO.

1301 Woodswether Road
KANSAS CITY 6, MO.

DISTRICT BRANCH OFFICES

S. T. Burton Co., 228 N. LaSalle St., Chicago 1, Ill.
George R. Lewis Co., 2836 Queen Ave. S., Minneapolis 5, Minn.
B. H. Mueller Co., 6825 Delmar Blvd., St. Louis 5, Mo.
Ole K. Olsen Co., 823 Perdido St., New Orleans, La.
Philip D. Barnard, 2080 Addison, Houston 5, Tex.
Western Steel Prod. Co., 1755 W. 13th Ave., Denver 4, Colo.

WHY WASTE STEAM?



Equip HARD-TO-REACH VALVES with Low-Cost

Babbitt *Adjustable* SPROCKET RIM *with Chain Guide*

• Range of 10 adjustable sizes takes care of all valve makes and types; fits valve wheel diameters from 2 to 38 inches.

• Much steam is wasted in industrial plants because overhead, out-of-reach, inaccessible valves either remain untouched and open, or are subject to hit-or-miss control. Turn this waste into dollars saved. Put those valves to work by getting the low-cost BABBITT Adjustable Sprocket Rim with Chain Guide. Valve control thus becomes easy, quick, regular—right from the floor!

• The BABBITT Adjustable Rim fits all valves, with either rising or non-rising stems. It is installed quickly by clamping onto the hand wheel of the valve.

• *Write today for Catalog Bulletin P, surprisingly low prices, and name of nearest distributor.*

BABBITT STEAM SPECIALTY CO.

1 Babbitt Square, New Bedford, Mass.

More POWER NEWS

Begins on page 154

A new section of the **National Assn of Corrosion Engineers** to serve the extensive paper and power industries of central Wisconsin was organized May 7 at a meeting at Engineers' Society of Milwaukee Building. A petition for recognition as an NACE section was completed and forwarded. This is the twenty-third local section formed by the Association. The next nearest local organization is at Chicago.

Battery Additives Condensed by Study

Recent investigations by P L Howard and G W Vinal of the National Bureau of Standards have shown that battery additives—preparations frequently sold with claims that they will rejuvenate "dead" batteries—have in fact no effect on battery life or performance. Extensive laboratory tests simulating actual service conditions were made on a wide variety of commercial additives. Results show no significant difference between the batteries treated with these mixtures and similar untreated batteries used as controls.

During the last 30 years, more than 100 different battery additives, both powders and solutions, have appeared on the market. Most of the solutions have consisted of sulfuric acid, sometimes with additions of sodium sulfate, magnesium sulfate, or coloring matter. In connection with a broad program of research on the properties of batteries, the Bureau investigated the liquid preparations several years ago and found they produced no essential difference in the charging, voltage, efficiency, or operating temperature of a battery. Today, however, most of the common additives consist of combinations of magnesium and sodium sulfates in various states of hydration. The present investigation was, therefore, concentrated on these substances as representative of the powdered additives.

Uranium Ore Refinery Planned

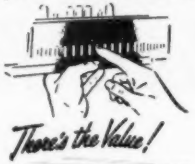
The United States Atomic Energy Commission will construct a uranium ore refinery and other facilities for the production of uranium feed materials on a 1200-acre site near the Miami River, 19 miles northwest of downtown Cincinnati, Ohio. The new installation will produce uranium in forms suitable for use in the AEC's fissionable materials' production plants.

The new facilities are being designed by Catalytic Construction Co of Philadelphia. Acquisition of the land will be undertaken by the Louisville (Ky.) District Office of the Corps of Engineers and construction will begin as soon as right of entry to the site has been obtained. Final selection of construction and operating contractors has not yet been made.

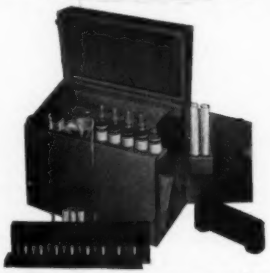
Exact boundaries of the site have not yet been determined, but it lies north of Fernald Station, Ohio, between the Chesapeake and Ohio Railroad and US 50 (bypass).

KEEP
SCALE
TO A MINIMUM

CHECK BOILER WATER FOR pH AND PHOSPHATE



IT'S FAST AND EASY WITH A TAYLOR BOILER WATER COMPARATOR!



It takes only a minute or two to determine pH or Phosphate, since all color standards necessary for a determination are enclosed in one plastic slide... no breakable single standards to handle. Maximum accuracy is assured... *for all Taylor Liquid Color Standards carry an UNLIMITED guarantee against fading.* Their low cost, extreme accuracy and simplicity of operation have made Taylor Boiler Water Comparators the accepted tool throughout industry.

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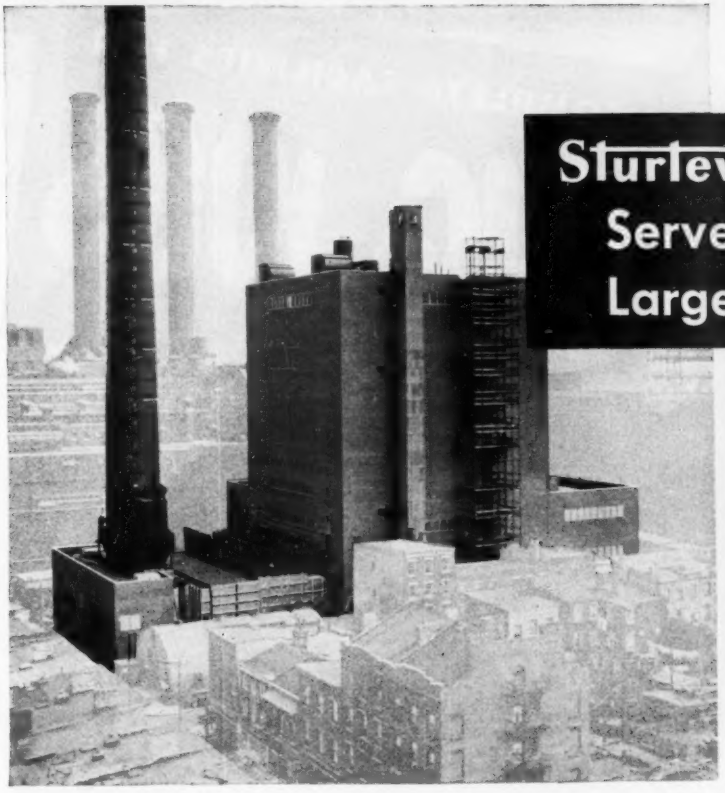

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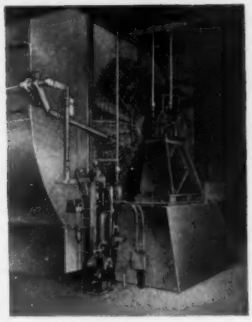

One of the TURBOVANE® 10 Forced Draft Fans, showing its VANE CONTROL® mechanism.

Rated at 1,300,000 lbs. of steam per hour, the largest boiler now in operation required the most dependable forced and induced draft fans available.

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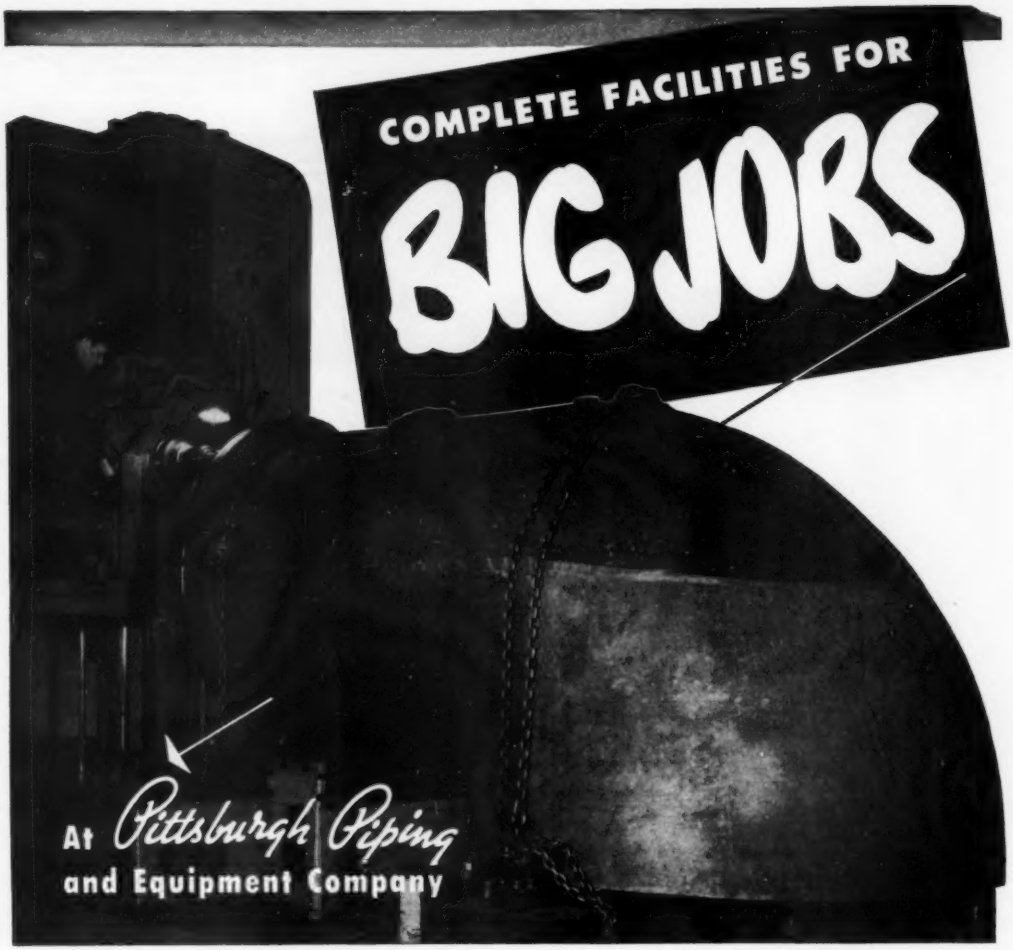

Machining a casting of this size requires special equipment—big equipment for handling big jobs.

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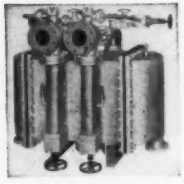

Engineers' fears of porous castings have led many to specify separate inter-after condensers with air ejectors. These fears are now totally dispelled with the new C.H. Wheeler Steel Shell Tubejet Air Ejectors. Designed originally to attain compactness for marine installations, thousands of these ejectors rendered outstanding service in World War II. This streamlined version of the older design effects considerable savings in space and weight. They are being widely adopted for stationary power plant use. Available with either single or multiple element, two-stage type with combined surface inter-after condenser. The coupon will bring you Specification 88, just released. It shows preferred method of piping to control hotwell level in main condenser.

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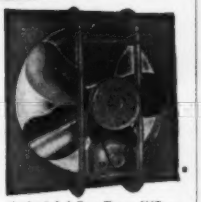

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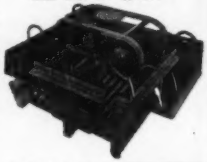

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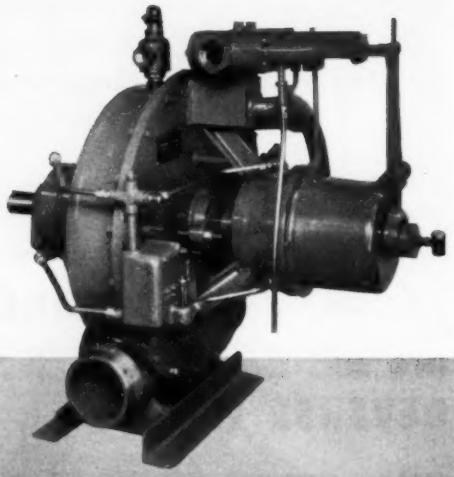

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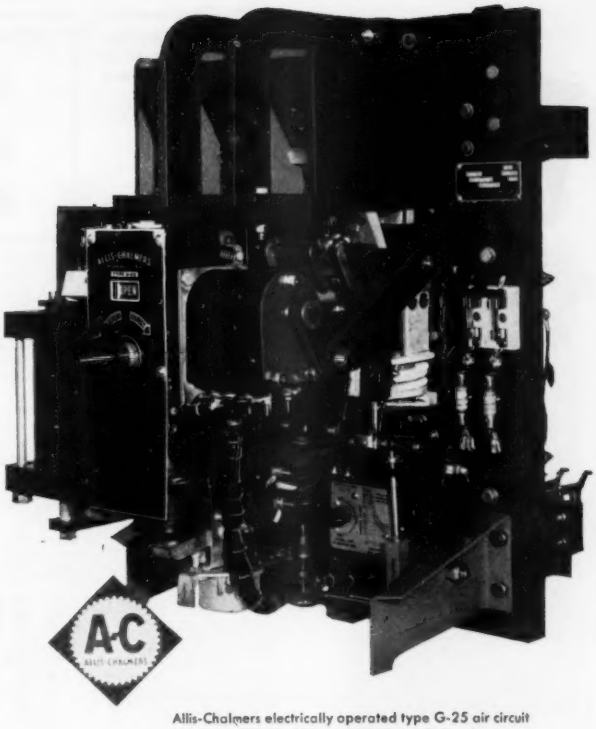

Allis-Chalmers electrically operated type G-25 air circuit breaker; 600 V., 600 A., 25,000 A-I-C. Breaker components mounted on panel of K&M Ebonized Asbestos.

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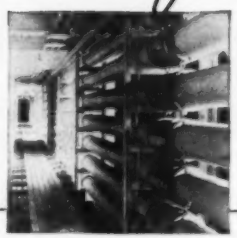

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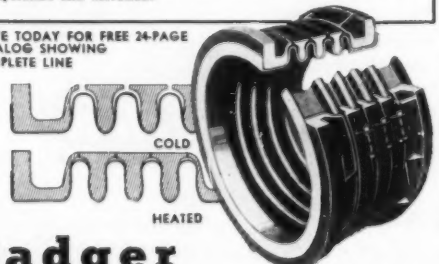

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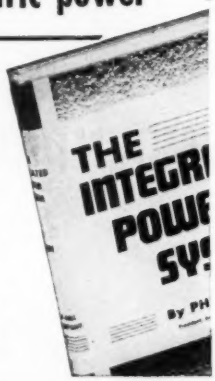

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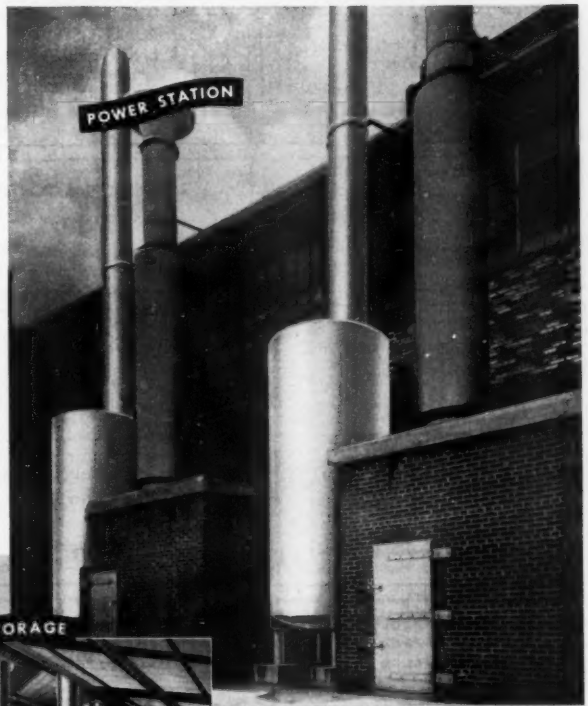

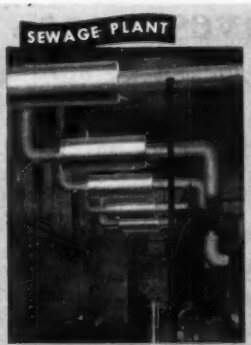

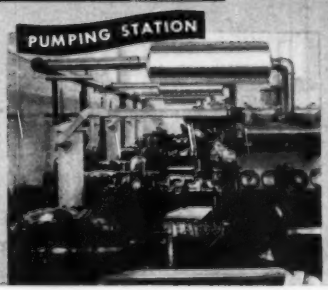

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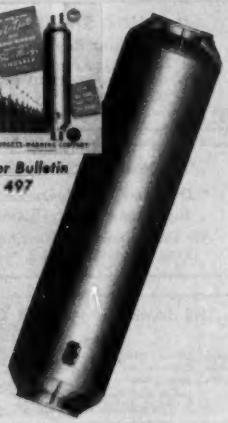

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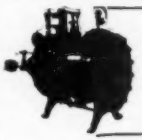

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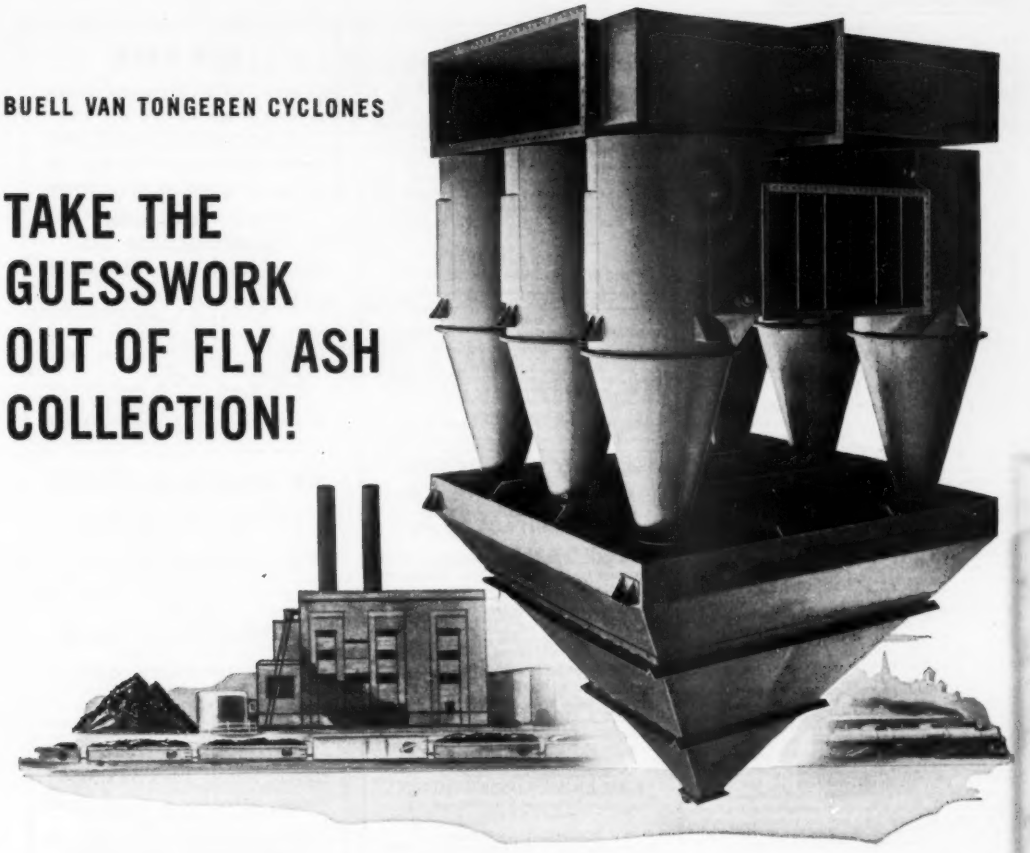

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buell

Engineered Efficiency in **Fly Ash Collection**

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REPLIES (Box No.):
Address to office nearest you
NEW YORK: 330 W. 42 St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

ASSISTANT SUPERINTENDENT for central heating plant. State age, salary, and full details in first letter. Send sample of writing. Address: University Engineer, c/o Department of Building & Grounds, University of Idaho, Moscow, Idaho.

SELLING OPPORTUNITY OFFERED

ATTENTION ENGINEERS—You get the commission when you use our Sludge-Solvent or Soot-Remover. For particulars write Amionic Chemical Co., P. O. Box 371, Taunton, Mass.

EMPLOYMENT SERVICES

SALARIED POSITIONS $3,500 to $35,000. We offer the original personal employment service (established 41 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered; present position protected. Ask for particulars. R. W. Bixby, Inc. 270 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL $3,000-$25,000. This confidential service established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. G, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

POWER PLANT Supervisor—eight years' experience in the operation and maintenance of modern power plant, also some construction and refrigeration experience. Technical education. Age 30. PW-9437, Power.

MECHANICAL ENGINEER, 6 years varied experience U.S. & Latin America in power trans. & gener., also refrig. Speak & write Spanish. PW-9887, Power.

SALES/GUARANTEE Engineer — Seventeen years experience High pressure steam operation, construction and repair. Marine and Shore Chief Engineer Licenses. Two years sales promotion and Advertising. Excellent references confirming engineering and executive ability. Age 36. Willing to travel if wife can accompany. Private aircraft pilot license. Member ASNE. PW-9997, Power.

POWER PLANT Superintendent — Operating and/or construction—10 year senior experience—B.S. in M.E. and E.E.—now completing foreign assignment on large high pressure station—available 30 to 45 days notice—location unimportant if project is interesting. PW-1036, Power.

POWER HOUSE operating engineer with 27 years experience at operating all power house equipment. Would consider taking charge of small plant or an operator in a larger plant. PW-1051, Power.

POWER PLANT Operation: College graduate, 43, with 20 years experience in operation, testing and maintenance of modern steam plant equipment desires responsible operating position. At present in Foreign Service. Available for interview August 1st, 1951. PW-1013, Power.

POSITION WANTED

MECHANIC, MACHINE Tool operator, blacksmith also B.S. in M.E. and Reg. P.E. Eight years experience as consultant on industrial power plant operation. Want Plant Engineering or Maintenance position. Age 35. Family. PW-1092, Power.

OPERATION-MAINTENANCE Supt. or Asst. Twenty years experience with intimate knowledge of power plant and industrial steam and elec. generation and distribution. Also maintenance in large chemical process plant. Excellent personnel training and handling record. Some design and modernization. Available at once. PW-1065, Power.

PATENTS

Consult: Z. H. Polacheck.

Reg. Patent Attorney, 1234 Broadway, New York 1, N. Y.

ATTENTION—SALES MANAGERS

A New England Industrial Sales Organization—with Salesmen calling on the Industrial-Marine and Power Industries desires additional lines—Are You Represented in New England? If not, write

RA-9968, POWER
330 W. 42 St., New York 18, N. Y.

IF YOU ARE AN
OUTSTANDING SALESMAN
with EXECUTIVE ABILITY

There is an opportunity to become a Field Sales Supervisor for a leading corporation selling fuel oil treatments, soot removers, and water treatments. Producing territories assigned for supervision. This is an interesting proposition for a competent salesman, not afraid to do a great deal of travelling and work hard. Our employees know of this opening. Your replies will be kept confidential.

Write in detail to

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WANTED
GRADUATE MECHANICAL ENGINEERS

For employment in Power Station design engineering with a public utility. Various openings available for men with general layout, piping, and drafting experience. Location, Western Pennsylvania. Qualifications, experience record, salary desired, and picture should be submitted with letter of application.

P-9905, POWER
330 W. 42 ST. NEW YORK 18, N. Y.

ADD TO YOUR PROFITS

MANUFACTURERS REPRESENTATIVES AND DEALERS WITH POWER PLANT BACKGROUND

Sell **BORGANA** Remarkable organic treatment for boilers and water systems for prevention of scale and corrosion.

- Unconditionally guaranteed
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- Nationally advertising
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A FEW SELECT TERRITORIES NOW OPEN
CHEMICAL DIV. PORTLAND SHINGLE CO.
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New England Boiler Setting Co.
Specialists on
FIRE BRICK CONSTRUCTION
Industrial Furnaces
Expert Repairing
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166 Webster St. Arlington 74, Mass.

STOKER FOR SALE

Detroit Single Retort UniStoker—6' 6" wide by 5' 6" long—35.7 Sq. Ft. active grate area. Applicable to 150 H.P. nominally rated boiler with forced draft fan with capacity for 175% of rating. Equipped with 7½ H.P. motor and spare parts.

Stoker new in 1940 and is in excellent condition. Would cost about $3,000.00 today, will sell for $1,200.00 immediate delivery.

DEARNLEY BROS.
PHILADELPHIA 44, PA.

MOTORS

2—1000 HP 300 RPM Syn. 3-60-2300 V—8 P.F.
NEW
IN STOCK — REBUILT
Motors, Control, Drives—All Types, Compressors, Pumps, Conveyors.
ENSLOW MACHINERY CO.
1401-8th Ave. Huntington, W. Va.

FOR SALE

2—Late 2000 KW GE Turbo Generators
2—4000 HP Sync. Motors—257 RPM
1—Rotary Compressor 60000 CF/H 4#
1—IR Compressor 20,000 CF/H @ 100#
1—Deaerating F.W. Heater 10,000#/hr.

UTILITY EQUIPMENT & CONSTRUCTION CO.
316 So. LaSalle Street, Chicago, Ill.

FOR SALE

2—Oil circuit breakers, 72,000 v, 400 amp. West. Type G1.
2—Transformers, GE. 018E. 150 kva. 7200/12, 470Y-120/240, single phase.
60 kw West. turbo generator
20,000 gal. per day F.W. double effect distillation unit.

LEWON BROS.
367 Bayshore San Francisco 24, Calif.
Phone: ATwater 2-2726

Air Compressors Wanted

Horizontal Water Cooled—Any size
also 2 Stage portable unit

L. W. BAUER
North Bergen, N. J.

CASH
FOR TRANSFORMERS—MOTORS
See Our Ad, Page 245
ELECTRIC EQUIPMENT COMPANY
63 CURLEW ST., ROCHESTER 1, N. Y.
Glenwood 6783 LD-65

WANTED TO BUY — For Cash
YOUR SURPLUS
ELECTRIC MOTORS • MOTORS STARTERS
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INDUSTRIAL ELECTRIC & SUPPLY CO., INC.
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BUYERS OF SURPLUS COPPER INSULATED WIRES AND CABLES

No lengths too long or too short
TELEPHONE: EASTGATE 7-4778
PIERCE CABLE CO.
2668 CLYBOURN AVE., CHICAGO 14, ILLINOIS

WANTED
WATER TUBE BOILER

1 (One) one thousand horse power sectional header, 4 inch water tube boiler, approved 200# pressure.

W-9763, POWER
330 W. 42 St., New York 18, N. Y.

If there is anything you want
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Advertise it in the
SEARCHLIGHT SECTION

REDUCING-DESUPERHEATING VALVES, MOTOR-OPERATED
(Schutte & Koerting)

Quantity	Size	Capacity lb/hr	Pressure psig	°F Temp.	Quantity	Size	Capacity lb/hr	Pressure psig	°F Temp.
3*	2" x 3"	20,000	1340	935	3*	4" x 8"	35,000	500	650
1	3" x 6"	50,000	1350	850	1	6" x 12"	50,000	500	470

*One each in original shipping crates. All others listed were used not over 500 hours each.

FS1129 POWER, 520 N. Michigan Ave., Chicago 11, Ill.

Additional Positions Vacant Ads on the opposite page

ENGINEERS

Electrical Mechanical Structural

Openings in Ohio and New York offices offering long term employment with good salary for qualified Group Leaders, Designers and Draftsmen experienced in one or more of the following phases of industrial plant design:

Electrical Power, lighting layouts and electrical controls.

Mechanical Plant layout, process piping, conveyors, heating and ventilation, boiler houses, process equipment layout, refrigeration, plumbing, tanks and vessels, packaging equipment, special machinery and equipment.

Structural Structural steel and reinforced concrete.

Please submit complete resume stating experience, education, salary required and availability date.

THE H. K. FERGUSON COMPANY
Engineers and Builders

The Ferguson Building
1783 E. 11th St., Cleveland 14, Ohio **19 Rector St., New York 6, N. Y.**

BOILER DRAFTSMEN and DESIGNERS

SPRINGFIELD BOILER CO., 1953 East Capitol Avenue, Springfield, Illinois, is located right in the center of the U.S.A. food producing area. Springfield is *not* near large industrial war equipment producing areas. Your family will enjoy ideal living conditions and, particularly, the fine temperate climate. Springfield has a large lake—for boating, swimming and fishing.

Now we are expanding our activities in the boiler manufacturing field and must increase our engineering and drafting force. We need boiler draftsmen and designers for permanent employment—experienced in heavy and light plate work, structural steel, pressure vessels, piping and similar work.

Our employer-employee relations are excellent. People live peacefully here in the center of the prairie state and are friendly and neighborly.

MAY WE HAVE YOUR APPLICATION?

Wanted

ENGINEERS AND SCIENTISTS

Unusual opportunities for outstanding and experienced men.

These top positions involve preliminary and production design in advanced military aircraft and special weapons, including guided missiles.

Immediate positions include:

- Electronic project engineers
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- Power plant installation designers
- Structural designers
- Electro-mechanical designers
- Electrical installation designers

Excellent location in Southern California. Generous allowance for travel expenses.

Write today for complete information on these essential, long-term positions. Please include resume of your experience & training. Address inquiry to Director of Engineering.

NORTHROP AIRCRAFT, INC.
1011 E. Broadway
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POWER

SUPERINTENDENT WANTED

for large paper mill power plant located in the South. Must be experienced with high pressure boilers and process steam operations. In first letter give college background, experience, marital status, etc. Write P.O. Box 1844, Savannah, Georgia.

When Answering BOX NUMBERS...

to expedite the handling of your correspondence and avoid confusion, please do not address a single reply to more than one individual box number. Be sure to address separate replies for each advertisement.

UNPARALLELED OPPORTUNITY for COMBUSTION EQUIPMENT SALES ENGINEERS

National Spreader Stoker Sales Organization requires services of Sales and Combustion Engineers of proven sales ability to contact concerns using boilers to make steam. This is a real opportunity for Combustion Engineers to go into business for themselves and make money. Prospects are everywhere and waiting for our salesmen.

FYR-FEEDERS burn cheaper sizes of coal, wood chips, sawdust, hogged wood, etc., and PAY FOR THEMSELVES quickly. Average annual SAVINGS run from $24 to $90 per rated boiler horsepower. Wet coal is no problem.

FYR-FEEDERS replace underfeed coal stokers, spreader stokers, pulverized coal burners, oil and gas burners. Coal savings run from 25% to 78%.

FYR-FEEDER Spray-Spred Stoker equipment is sold for Cash or on FYR-FEEDER Coal Savings Purchase Plan . . . no capital investment required . . . all payments *out of actual savings as made.*

Salesmen who sell only 24 average size FYR-FEEDERS annually will earn $15,000 per year in commissions. On 48 sales per year, commissions will run more than $40,000. No investment by salesmen required; but must have car.

Additional commissions can be made by selling our FLO-MATIC (bin to boiler) Wood or Coal Conveyors which are a necessity in every boiler room to conserve manpower.

If qualified we will train you in Chicago. For interview, phone SUperior 7-3264, or write—

American Coal Burner Company
18-R East Erie St. • Chicago, Ill.

TO INDUSTRIES BURNING COAL *and/or Wood Waste Fuel*

We will **CONTRACT** to *substantially* **CUT** *your* **COAL COSTS.** This we have done in **THOUSANDS** of installations.

AVERAGE ANNUAL SAVINGS
run from $24 to $90 PER RATED BOILER HORSEPOWER

Write for engineer to make savings estimate at no cost to you.

FYR-FEEDER ENGINEERS
Division American Coal Burner Company
18-R EAST ERIE STREET, CHICAGO, ILL.

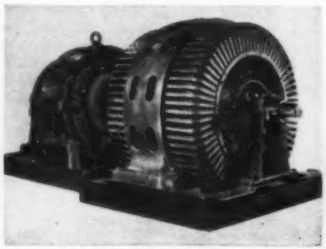
IT ISN'T RE-NU-BILT UNLESS

It Comes from

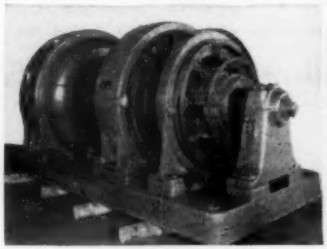
BELYEA

"SUCCESSFUL OPERATION GUARANTEED"

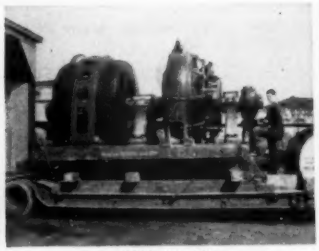
Three Recent Stock Arrivals



500 KW-MG



750 KW-MG



2000 KW-MG

MOTOR GENERATOR SETS

3 ph. 60 cycle

Qu.	KW	Make	Speed	D.C. Volts	A.C. Volts
2	2000*	G.E.	300		6600/11000
1	2000(3U)	G.E.	720	250	2400/4800
1	1500	Whse.	600	600	2300/4600
1	1500	G.E.	360	275	2200/4400
1	1400	Whse.	360	700	2300
1	1000	Whse.	900	600	2300/4150
1	1000(3U)	G.E.	900	250	2400/4800
1	800	Whse.(3U)	1200	600	2300
1	750	Whse.	900	250	2300
1	500	G.E.	900	600	4150
1	500	G.E.	720	125	2300/4000
1	400	G.E.	720	250	440/2200
1	400	G.E.	1200	120/240	440
1	400	Whse.	1300	250	2300
1	400	G.E.	900	275	2300/4150
1	350	G.E.	900	125	2300/4150
1	150	G.E.	1200	250	2300
1	150	Whse.	1200	275	2300
1	150	Cr. Wh.	1200	250	440
1	140(3U)	Cr. Wh.	600	125/250	2200
1	100	G.E.	1170	125	220
1	100	Delco	1200	125/250	440
1	75	G.E.	1200	125	4000
1	75	G.E.	1200	250	440
6	70	G.E.	1300	70	220/440

*25 Cycle

ROTARY CONVERTERS

60 Cycles

Qu.	KW	Make	Speed	D.C. Volts	A.C. Volts
1	2000	G.E.	514	600	13800
1	1000	Whse.	900	600	11000
1	750	Whse.	900	600	13200

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	6000	Al. Ch.	Condensing 200/250 ISP 2300/3/60-Exc. & Surface Cond.
1	2500	G.E.	Auto. Ext. Cond. 800 lbs.-800# F.T.T. 175/200 Auto. Ext. 2300/3/60 Exciter & Surface Cond.
2	1000	G.E.	Non-condensing, 175/200 lbs. I.S.P., 5/30 lbs. G.B.P., 480/3/60.
2	750	G.E.	Condensing 425#-725#TT ISP-440V-3 ph. 60 cy. New — 1944
1	625	Whse.	Non-condensing, 125/150# ISP 5/20# B.P., 480 v., 3 ph., 60 cy., with exciter
2	500	G.E.	Non-condensing 175/200 lbs. I.S.P., 5/30 G.B.P., 480/3/60.
1	400	Whse.	Non-condensing 125/150# ISP 5/10#BTU 40/480v. 3 ph. 60 cy.
1	300	G.E.	Non-condensing 150/175# ISP 5/15# B.P. 480V. 3 ph. 60 cy.
1	300	Al. Ch.	Condensing 425# ISP Geared to 1200 RPM 120/240V. D.C.
1	200	Whse.	Non-condensing 150# ISP 7# B.P. 240 V. 3 ph. 60 cy.

D. C. MOTORS

HP	Make	Type	Volts	Speed
1—1750	West.		600	525/720
1—1500	Whse.		525	600
1— 940	Whse.	QM-B Brg.	250	140/170
1— 800/1000	Whse.		450	600/720
1— 600	Al. Ch.	MILL	230	440/800
2— 450	Whse.		550	415
1— 300/400	G.E.	DYNA	250	1325/2500
1— 250	Cr. Wh.	CCM-151H	230	1100
1— 335	Whse.	MQ	250	300/900
1— 200/300	G.E.	MPC	230	360/920
1— 250	G.E.	MPC	230	400/500
1— 150	G.E.		600	250/750
10— 150	Cr. Wh.	83H	230	890
1— 150	Cr. Wh.	CMC-65H	230	1150
1— 150	Whse.	SK-201	230	360/950
1— 50/120	G.E.	MCF	230	250/1000
4— 75	G.E.	TLC-50	250	850/2500

FREQUENCY CHANGERS

1—1000	A.C.	25/62½			2300/2300
1—1000	G.E.	25/58	Cycle		4400/2300
1— 500	A.C.	25/60	Cycle		11000/2300V

SYNCHRONOUS CONDENSERS

Qu.	Kvs.	Make	Volts	Speed
1	5140	Whse.	4150	600
1	3000	Whse.	4800	720

TRANSFORMERS

60 Cycles

Qu.	KVA	Make	Type	Ph.	Voltages
2	4000	G.E.	HT	3	23000x2300
3	1250	G.E.	H	1	6600x500
1	1050	G.E.	WCTH	3	11000x445
1	500	Whse.	OISC	1	34650x432
3	333	Maloney	OISC	1	13200x240/480
6	300	G.E.	HT	3	13200x240/480
2	300	G.E.	HT	3	6900x240/480
9	200	G.E.	HT	3	2400x240/480
3	150	Maloney	OISC	1	13800x2300/4600
1	100	G.E.	H	1	450x230

RECTIFIERS

1— 750	G.E.	BHW	575	2300
1—1000	A.C.	B-612	625	13500
1—1000*	A.B.B.	GRZ	625	6600/13200

*This unit with full automatic control good for both 25 and 60 cycle.

A. C. MOTORS

3 ph. 60 cycle

SYNCHRONOUS

HP	Make	Type	Volts	Speed
2—3500	G.E.	TS	2300	257
3—2000	Whse.		2300	138
1—1470	Whse.		4600	900
2— 900	Al. Ch.	(New)	2200	150
2— 735	G.E.	ATI	2200/12000	600
1— 650	Whse.	G	2200	138
1— 600	Whse.	Syn.	440	360
1— 450	Whse.	Eng.	2200	128.5
2— 350	G.E.	TS	2200	150
1— 300	Whse.		2300	720
1— 300	Whse.	G	440	900
1— 125	G.E.	ATI	440	450
1— 100	Whse.		550	600

SLIP RING

1—1000	Whse.	CW	2300	444
2— 500	G.E. unused	M-574Y	2200	900
1— 500	G.E.	IP	550	565
1— 500	G.E.	IM-Mill	2200	450
1— 500	G.E.	IM	440	900
1— 350	G.E.	MT-442-Y	2200/4000	253
1— 300	Al. Ch.	3 Brg.	2300	505
1— 300	G.E.	IM	440	720
1— 300	Al. Chal.	ANY	2200	708
1— 250	Al. Chal.	ANY	440	585
1— 250	G.E.	M-567-TEFC	440	600
1— 250	G.E.	MT-424Y	4000	257
1— 250	G.E.	MT-559S	2200	1750
1— 250	Al. Chal.	ANY	550	600
1— 200	Al. Ch.	ANY	440	440
1— 200	G.E.	MTP	440	1170
1— 150	G.E.	IM-15	440	695
1— 150	Al. Chal.	ANY	440	580
4— 125	G.E.	MT-566Y	440/2200	435
4— 100	G.E.	MT-566Y	440/2200	425
1— 100	G.E.	IM-16	2200	435
3— 100	G.E.	IM	440	600
3— 100	Al. Ch.	ANY	440	695
1— 100	G.E.	MT-556	2200	900

SQUIRREL CAGE

2— 650	G.E.	FT5503Y	440	3570
2— 450	Whse.	CS	2300/4150	354
1— 300	G.E.	IK-17	440	580
1— 200	G.E.	KT-557	440	1800
1— 200	G.E.	KT-574Y	2300	505
1— 200	G.E.	IK-17	440	590
1— 150	Watghse.	C88568	440	880
1— 125	Whse.	MS	440	885
1— 125	(New) G.E.	KF-TEFC	440	1190
1— 125	G.E.	KF-TEFC	440	3585
3— 125	Al. Ch.	ARW	2200	1750
1— 125	G.E.	IK	220	900
1— 100	G.E.	IK-Vert.	2300	450
2— 100	G.E.	KT-513	220/440	1750
1— 100	G.E.	KT-556	440	900

RE NU BILT BELYEA MOTORS

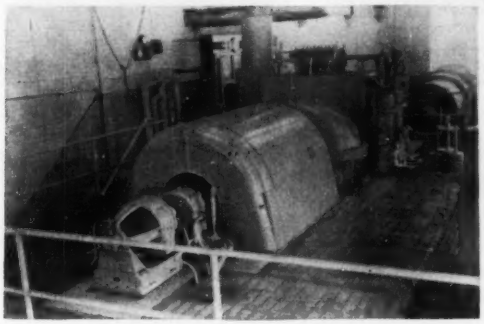
BELYEA COMPANY, Inc.

43 HOWELL ST., JERSEY CITY, N. J.

PHONE—JOURNAL SQUARE 2-3334

N. Y. LINE—RECTOR 2-7150

• TURBO GENERATORS •

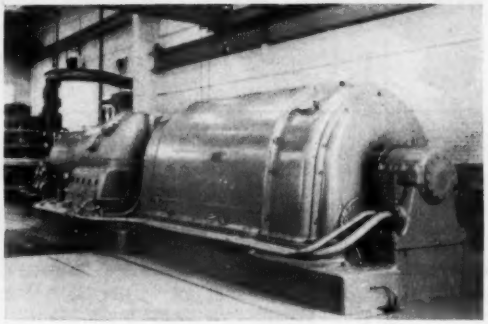


Actual Photo—2500 KW

GENERAL ELECTRIC TURBO UNIT

TURBO: 2500 KW, 3600 r.p.m., Form AA, 11 stage, 800 lbs. G. AUTOMATIC EXTRACTION, 2½" abs. condensing.
GENERATOR: 2500 KW, 3600 r.p.m., 3125 KVA, 80% p.f., type ATB-2 form T, 3 phase, 60 cycle, 2300 volt.
EXCITER, 25 KW, 125 volt, 3600 r.p.m. direct connected. Complete operating panel.
CONDENSER: Alberger, surface type, 2 pass, complete with circulating, condensate and air removal pumps.
WATER RATES: Calculated at 800 lbs. I.S.P., 750° F.T.T., and 2½" abs.—KW—Lbs. per KW Hr.

3125 KVA	10.89	1875 KW	11.22
2500 KW	10.89	1250 KW	11.92



Actual Photo—6000 KW

ALLIS CHALMERS TURBO UNIT

TURBO: 6000 KW, 3600 r.p.m., 200/225 lbs. I.S.P., 550° F.T.T., 2½" abs., condensing.

GENERATOR: 6000 KW, 3600 r.p.m., 7500 KVA, 80% p.f., 3 phase, 60 cycle, 2300 volt.

EXCITER: 50 KW TURBO UNIT, 125 volt complete operating panel.

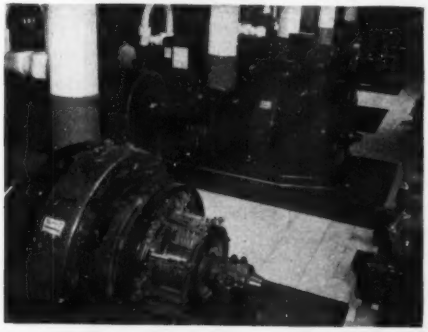
CONDENSER: ALLIS-CHALMERS, Surface type, 2 pass, complete with circulating, condensate and air removal pumps.

This installation may be purchased in its entirety or in parts, and we will be pleased to supply additional information upon inquiry. The 2500 KW G.E. Electric Unit served as a topping installation for the 6000 KW Turbo Unit; and associated equipment included one

• B & W STIRLING BOILER •

100,000 lbs. per. hr., 800 lbs. pressure, 800° F.T.T. complete with pumps, pulverizers, gauges, valves, and standard trim.

Recently Acquired Geared D.C. Turbo Units



2—1000 KW—G.E.—Non-Condensing 200# ISP—100° S.H.—5/10# B.P. 250V. D.C.

1—1000 KW—Moore-GE. Condensing Mixed Pressure—200# ISP—100° S.H. 250V. D.C.

2—500 KW—G.E. Non-Condensing 200# ISP—100° S.H. —5/10# B.P.—250V. D.C.

Photo at left shows installation can be inspected as shown.

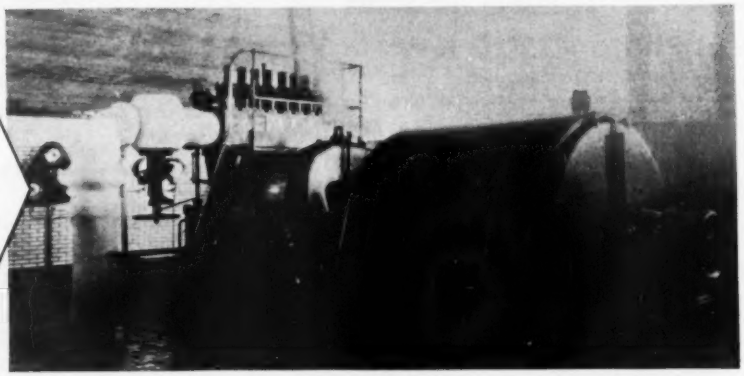
BELYEA COMPANY, INC.

43 HOWELL STREET JERSEY CITY 6, N. J.

POWER for

Don't wait 18 months or more for the Power We can give you prompt delivery on Complete

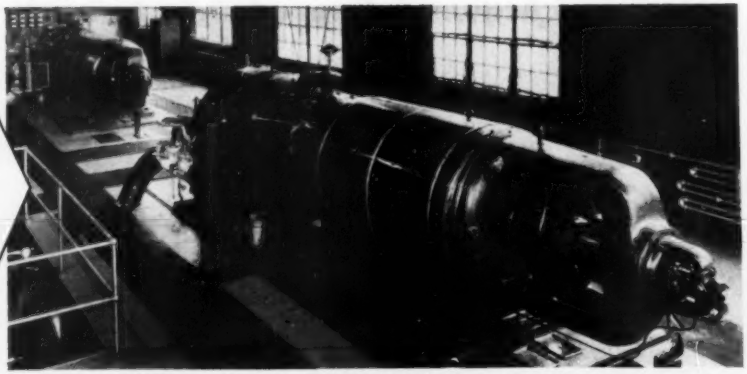
SEND TODAY for BULLETIN 415 Complete Specs.



5000 KW-G.E. TURBINE GENERATOR

General Electric Condensing, 200# psig., 3/60/2300/4160-volt. Very complete Unit. Condition, good. Deliver DUTY FREE in Canada and USA.

SEND TODAY for BULLETIN 900 Complete Specs.



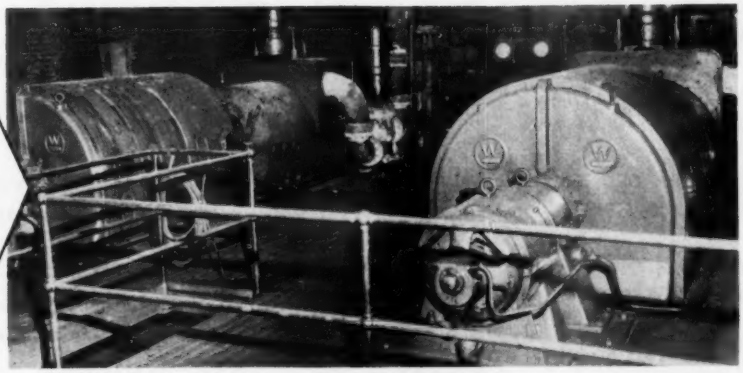
2500 KW-G.E. TURBINE GENERATOR

Two (2) 2500-KW., G.E., Condensing, 160/225-psig., 3/60/2300/4160/6900-volt, 450-F.TT, 3600-RPM., Condition A-1. Two Surface Condensers, 2-pass, 6750-sq. ft., with Auxiliaries. Immediate Delivery.

Production !

Equipment that you need TODAY!
Power Units anywhere in U.S. or Canada

SEND TODAY for BULLETIN 405 Complete Specs.



40/50# BACK PRESSURE TURBINES

One 2000-KW., Westinghouse, non-condensing, available. 250/350-psig., 350° FTT., 3/60/2400-volt. Condition, excellent, very limited service. Immediate Delivery.

OUR SPECIALTIES

POWER GENERATING EQUIPMENT

TURBO-GENERATORS BOILERS DIESEL POWER

We have in Stock 25 Complete Sets of Turbine-Generators. Capacities 500-KW to 20,000-KW. All Good Units. Boilers, Diesel Power—A Full Line of Both.

Send Us Your Specifications of Anything Needed

JUST ISSUED: OUR 1951 STOCK LIST: Send for it Today: Is FREE

TELEPHONE. WIRE OR WRITE.

CHARLES WEAVER, M.E.

41st FLOOR PENOBSCOT BLDG.
DETROIT 26, MICHIGAN

TELEPHONES
WOODWARD 1-1340
WOODWARD 1-1341
WOODWARD 1-6038

BERGER'S LARGE MOTORS

BALL BEARING & SLEEVE BEARING

SQUIRREL CAGE AND ALL VOLTAGES

2—100 HP Allis C., Type ARW-SB, 1800-3-60-4160/2300 V.

1—100 HP Crocker W., S.B., Type SC, 1800-3-60-220/440 V.

1—100 HP Wagner, OSB, Type 38T-SBH, 450-3-60-2300 V.

1—100 HP Wagner, OSB, Type 38T-SBH, 450-3-60-550 V.

3—100 HP Fairbanks M., Type H-BB, 1200-3-60-220 or 440 V.

1—125 HP Wagner, OSB, Type 38T-SBH, 514-3-60-2300 V.

3—HP Fairbanks M., BB, Type H, 1800-3-60-220 or 440 V.

1—125 HP, G.E., Type KF, BBSP, Frame 539Z, 3600-3-60-2300 V.

3—125 HP Wagner, Type 26VSBM, 1200, 3-60-2300 V.

1—150 HP Wagner, OSB, Type 38T5BM, 450-3-60-2300 V.

1—150 HP Wagner, Type 38T-5BM, 600-3-60-2300 V.

1—150 HP G.E., Type IK, Frame 16, 600-3-60-220 or 440 Volts.

1—150 HP Allis C., Type AR-BB, 3600-3-60-2300 V.

1—175 HP Wagner, SB, Type 38T-5BM, 720-3-60-2300 V.

1—175 HP Wagner, SB, Type 38T-5BM, 720-3-60- 550 V.

1—175 HP West., Type CS, OSB, 1200, Frame 950.01H, 1200-3-60-220 V.

20—200 HP Wagner, OSB, Type RP2, Frame 26, 1800-3-60-440 V.

1—200 HP Reliance, Type AA, Frame 6085-TE, Forced Ventilating, 900-3-60-220 or 440 V.

4—200 HP West., OSB, Type CS, Frame 950.01H, 1200-3-60-2300 V.

1—250 HP Wagner—Type RP1—31V—1800-3-60-440 V.

1—250 HP G.E., Type IK, 1200-3-60-440 V.

2—250 HP Westinghouse, Type CS, SSB, Frame 875S, 1800-3-60-2300 V.

1—250 HP Westinghouse, Type CS, SSB, Frame 1106, 450-3-60-440 V.

1—300 HP Westinghouse, Type CS, OSB, Frame 1106, 600-RPM—3-60-220 V.

1—300 HP Westinghouse, Type CS, OSB, Frame 1106, 600-3-60-2300 V.

1—300 HP Westinghouse, Type CS, OSB, Frame 9356, 1200-3-60-440 V.

1—325 HP Westinghouse, Type CS, OSB, Frame 1106, 600-3-60-440 V.

Bergerized motors have a factory guarantee of one year look and will perform like brand new.

PHONE • TYler 8-4400

J.E. BERGER Corporation

4550 MAYBURY GRAND AVE. • DETROIT 8, MICH.

WORLD'S LARGEST INVENTORY

Established 1934 — D & B Rated

ELECTRIC EQUIPMENT CO., ROCHESTER, N.Y.—JULY LIST

ELECTRIC EQUIPMENT CO., ROCHESTER, N. Y. — A JULY LIST

WRITE FOR NEW 1951 CATALOG AND SPECIAL APPOINTMENT CALENDAR.

TRANSFORMERS

Quan.	KVA	Primary Volts	Secondary Volts	Phase
2	3000	23,000	2300	3
1	1500	2,300	600	3
1	1000	2,300	220	3
6	1000	66,000	7200	1
3	750	2,400	480	1
6	500	2,400	480	1
3	500	12,000	2300	1
3	450	23,000	440	1
3	333	2,400	600	1
3	333	2,400	240/480	1
3	333	13,200	240/480	1
3	333	11,500	240/480	1
3	300	2,400	120/240	1
6	250	2,400	240/480	1

Plus 734 smaller units 1 KVA to 100 KVA

MOTOR GENERATOR SETS AC — DC

Quan.	KW	Make	Volts
1	1000	General Electric	250
6	1000	General Electric	600
1	750	Allis-Chalmers	250
2	500	Westinghouse	250
2	500	Westinghouse	1500
1	500	Westinghouse	125
1	400	Westinghouse	125/250
2	300	General Electric	125/250
1	300	General Electric	500
1	250	General Electric	250
1	200	Westinghouse	250
1	200	General Electric	250
2	200	General Electric	125
1	150	General Electric	250
1	150	General Electric	125
3	100	General Electric	125
4	100	General Electric	250
1	100	Allis-Chalmers	125/250

Plus 238 sets from 1 KW to 75 KW in stock.

DC TO AC

	Input	Output
1	300 HP—230 V.	200 KW, 440/60/3
1	125 HP—230 V	75 KW, 125 V, DC
1	25 HP—230 V	15 KW, 230/60/3
1	25 HP—230 V	15 KVA, 230/60/1
35	20 HP—230 V	12½ KVA, 440 V, 3 ph. .5 P. F.
40	7½ HP—230 V	7½ KVA, 120/60/1
20	6 HP—115 V	5 KW, 120/60/1
5	3 HP—115 V	2 KVA, 110/25/1
10	1½ HP—115 V	1 KVA, 110/60/1
10	1 HP—115 V	½ KVA, 110/60/1

ROTARY CONVERTORS

Quan.	KW	Make	Speed	Volts
5	500	General Electric	1200	250
7	400	Westinghouse	1200	250
1	100	General Electric	1200	250

P.S.—We Stock Explosion-Proof Motors—Class 1-D & 2-G

WANTED

3—200 KVA Transformers, 2400/240/480.

3—500 KVA Tranformers 13800, 230/460

1—400 HP, 2300/60/300 rpm slip-ring motor.

3—500 KVA Transformers 12000, 230/460

AC GENERATORS
ALTERNATORS—CONDENSERS

Quan.	KVA-HP	RPM	CYCLE
1	2500	720	60
1	2500	900	60
1	1675	600	40
2	1500	900	60
1	1430	514	60
1	1250	1200	60
1	1000	750	25
1	800	900	60
3	750	900	60
2	650	139	60
1	500	720	60
1	500	750	25
1	400	450	60
8	400	1800	60
1	350	750	25
1	350	720	60
1	350	225	60
1	333	1800	960
1	320	1200	120
1	300	750	25
1	300	180	60
1	250	720	60

Plus 78 smaller units from 3 KVA to 200 KVA

SLIP RING MOTORS

Quan.	HP	Speed	Make
1	600	1800	G. E.
1	500	1800	G. E.
1	500	514	Al. Ch.
4	500	900	G. E.
1	350	720	G. E.
1	300	450	G. E.
1	300	514	G. E.
1	300	900	G. E.
1	300	720	G. E.
1	200	600	G. E.
1	200	1200	G. E.
2	150	720	G. E.
1	125	1200	Al. Ch.
1	100	900	Wagner
4	100	450	G. E.
8	75	720	West.

Plus 537 smaller units 1 HP to 40 HP

Mr. "Reddy" Cash

Wants Your Surplus List!

Note: We Stock 6000 New Motors, Controls, Frequency Changers

SEND US YOUR INQUIRIES!

DC MOTORS
ADJUSTABLE SPEED—230 VOLT

Quan.	HP	Make	Volts
1	300	General Electric	400/800
1	250	West.	250/675
4	40/250	West.	540/3000
1	150	West.	300/900
1	100	Reliance	500/1500
1	100	G. E.	400/1000
1	100	West.	450/1350
1	100	G. E.	1050/4000
1	90	F. M.	500/1500
1	75	G. E.	400/1200
1	60	G. E.	220/1000
1	60	G. E.	300/1200
1	50	G. E.	250/1000
1	50	G. E.	400/1200
1	40	G. E.	250/1000
1	40	Cr. Wh.	400/1600
1	35	West.	250/1000
1	35	G. E.	500/1000
1	30	Reliance	400/1200
1	30	Cr. Wh.	500/1500
1	25	Reliance	400/1600

Plus 327 smaller units 1 HP to 20 HP

60 CYCLE MOTORS
SQUIRREL CAGE MOTORS

HP	SPEED	MAKE
500	720	G. E.
400	1200	West.
400	514	West.
300	600	West.
250	3600	G. E.
250	1200	G. E.
200	600	Al. Ch.
200	1800	Wagner
150	720	G. E.
150	600	G. E.
150	1200	Al. Ch.
150	1800	Al. Ch.

P.S. We stock 3500 new and rebuilt 1 HP to 100 HP

CONSTANT SPEED 230 VOLT

HP OR KW	MAKE	Speed
400 HP	Elec. Dyn.	1500
300 KW	G. E. (170 V)	1200
300 HP	Cr. Wh.	1200
250 KW	Al. Ch.	720
150 KW	West.	720
125 HP	Star	1200
100 HP	G. E.	900
75 HP	G. E.	1200
75 KW	G. E. 325 V	1200
50 HP	West.	1200
50 HP	Burke	1800

Plus 675 smaller units 1 HP to 40 HP also 115 V & 550 V. DC.

SQUIRREL CAGE AND SLIP RING—25 CYCLE

Quan.	HP	Speed	Make
1	650	365 rpm	S.R.
1	350	750	S.C.
1	300	750	S.C.
1	300	375	S.R.
4	200	500	S.R.
1	200	750	S.C.
1	200	750	S.R.
1	200	500	S.C.
1	200	1500	S.C.

Plus 872 smaller units 1 HP to 150 HP

ELECTRIC EQUIPMENT COMPANY

PHONE LD 65

New and Rebuilt — ROCHESTER, N. Y. — 1 H. P. to 2500 H. P.

MOTORS · MG SETS · TRANSFORMERS · CONTROLS · COMPRESSORS

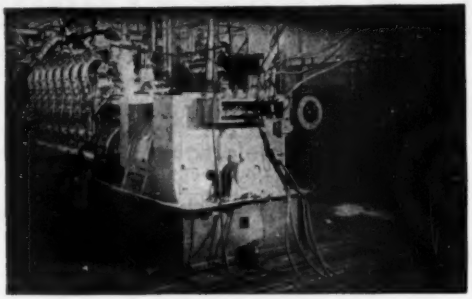
DIESEL POWER

AT 40% TO 60% SAVINGS

EACH ENGINE "REMANUFACTURED"
AND "FULL-LOAD TESTED"
PRIOR TO SHIPMENT

INSPECTION INVITED

ALL EQUIPMENT OFFERED WITH ONE YEAR GUARANTEE



VIEW OF ENGINE TEST STAND FACILITIES AT OUR PLANT IN SAUSALITO (S.F.) CALIF. ALL ENGINE TESTING CONFORMS TO DIESEL MANUFACTURERS' STANDARD METHODS.

A PARTIAL LIST OF OUR INVENTORY

KVA	MAKE	MODEL	HP	RPM	KVA	MAKE	MODEL	HP	RPM
1875	Fairbanks Morse	33E16	2000	300	375	General Motors	8-268A	450	1200
1420	Fairbanks Morse	38D	1600	720	312.5	Clark	GD-4	375	327
1250	General Motors	16-278A	1600	720	300	Fairbanks Morse	YVA	360	257
937.5	General Motors	12-567	1080	720	250	General Motors	8-268A	350	1200
625	Worthington	DD	750	300	237	Ingersoll-Rand	S	255	600
625	Alco	6-12½x13T	750	600	200	Buckeye	80	240	600
625	General Motors	8-567	720	720	125	Worthington	DD-5	150	600
425	Baldwin	VO	510	450	125	General Motors	3-268A	150	1200
400	Buckeye	80	480	600	75	General Motors	6-71	90	1200
375	Enterprise	DSG-6	450	450	62.5	Caterpillar	D-8800	76	1200
330	Superior	KNA	396	514	50	General Motors	4-71	60	1200

A. G. SCHOONMAKER COMPANY, INC.

52 CHURCH STREET, NEW YORK 7, N. Y.

SHOPS AND WAREHOUSE: JERSEY CITY, N. J. AND SAUSALITO (S.F.) CALIFORNIA

TRANSFORMERS

FOR SALE

2— 150 KVA. 60 CY. 1 PH. 2400-240/ SCOTT TAPS.
6— 100 KVA. 60 CY. 1 PH. 2400-240/120.
6— 75 KVA. 60 CY. 1 PH. 2400-240/120.
9— 50 KVA. 60 CY. 1 PH. 2400-240/120.
7—37½ KVA. 60 CY. 1 PH. 2400-240/120.
8— 15 KVA. 60 CY. 1 PH. 2400-480/240.

ALSO ALL TYPES OF AIR COOLED AND PHASE CHANGERS.

ATLANTIC TRANSFORMER CO.

5143 N. 2nd St. Philadelphia 20, Pa.

-TRANSFORMERS-

BOUGHT AND SOLD

We carry a large stock of transformers, and invite your inquiries.

PIONEER TRANSFORMER REBUILDERS

We rewind, repair and redesign all makes and sizes. *One Year Guarantee.*

THE ELECTRIC SERVICE CO., INC.

"AMERICA'S USED TRANSFORMER CLEARING HOUSE"

SINCE 1912 CINCINNATI 27, OHIO

MOTOR GENERATORS

1—1000 KW G.E. Syn. 250 V. 720 RPM
1—750 KW A-C Syn. 250 V. 720 RPM
2—300 KW G.E. Syn. 250 V. 1200 RPM
1—200 KW G.E. Syn. 250 V. 1200 RPM
1—200 KW G.E. Syn. 600 V. 1200 RPM
1—200 KW ELLIOTT Syn. 125/250 V. 1200
2—150 KW G.E. Syn. 250 V. 1200 RPM
1—100 KW G.E. Syn. 250 V. 900 RPM

ROTARY CONVERTERS

1—500 KW G.E. Syn. 250 V. 1200 RPM
1—500 KW G.E. Syn. 600 V. 1200 RPM
1—300 KW G.E. Syn. 250 V. 1200 RPM
1—300 KW WEST. Syn. 250 V. 1200 RPM
1—200 KW WEST. Syn. 250 V. 1200 RPM
1—150 KW G.E. Syn. 250 V. 1200 RPM
1—150 KW WEST. Syn. 250 V. 1200 RPM

ARMATURES

1—500 KW G.E. 250 V. MPC Gen. 900 RPM
1—300 KW G.E. 600 V. HCC Conv. 1200 RPM

WALLACE E. KIRK COMPANY

502 Grant Bldg., Pittsburgh 19, Pa.

TURBINE

WITH CLARK DRIVE

250 HP Whse. 1200 RPM with duplex drive, valves, governors & speed changer. Excellent condition.

MERRILL and COMPANY

407 So. Dearborn St. • Chicago 5, Illinois

Telephone: HArrison 7-8289

LAND can help you meet your Production Schedule with

Guaranteed Electrical Equipment

1 YEAR GUARANTEE

3—750 KVA Westinghouse Single Phase Transformers, Primary 13800/6900/4160/2400 volts—Secondary 460 volts.
Ready for Immediate Shipment

1 to 50 HP
NEW and REBUILT
TEFC—EX. FR.—Drip proof and Splash proof—Geared Head
IN STOCK

SQUIRREL CAGE MOTORS
3 phase

H.P.	Make	Type	Speed
200	G.E.	KT 557	1760
200	G.E.	KF-6335	880
150	West.	CS	580
150	G.E.	IK	870
150	West.	CS	870
125	Century (3)	SCN	1150
100	Century (7)	SCN	1150
100	Wagner (2) (NEW)	XP	1150
100	G.E.	K-544	1175
100	West.	CS	870
100	Al.Ch.		690
75	West. (2)	CS-654C	1750
75	G.E. (3)	K-505	1175
75	Cont. (2)	TEFC	870
75	G.E.	IK	900
75	G.E.	KT-352	867
75	West.	CS	720
60	F-M	TEFC (2)	1750
60	Howell	SCR	1800
60	West. (2)	CS-607	880
60	Rel.	AA	875
60	G.E.	KT-346	865
60	G.E. (2)	TEFC(GH)	427
50	G.E.	FTR-523	3600
50	Elliott	196	3450
50	West.	CS	1740
50	West.	XP	1150
50	G.E.	KF-445	1170
50	West.	CS-642C	1160
50	Wset. (3)	CS	870
50	G.E. (2)	IK	870
50	G.E.	FTR-542	870
50	West.	CS	690

SLIPRING MOTORS
3 Phase

H.P.	Make	Type	Speed
600	Cr.Wh.	131AQ	507
500	G.E. (2)	IM	450
500	Ideal		1150
225	Wagner	25 cy.	710
200	G.E. (2)	IM	1170
150	Wagner	31VRN	900
150	Burke		720
125	Burke		600
75	West.	CW	720
75	G.E.	MT556	900
75	G.E.	IM	690
60	West.	HF	850
60	Al.Ch.		690
50	G.E.	MT-536	1150
50	West.	CW	1150
50	L.A.	OGH	870
50	F-M	BV	600
50	Al.Ch.	ARY	575
50	G.E.	IM	490

SYNCHRONOUS MOTORS

H.P.	Make	Type	Speed
475	West.		720
300	G.E.	ATI	900
260	G.E.	TS	900
200	West.	Unused	900
180	G.E.	ATI	900
150	G.E.	TS	720
150	G.E.	ATI	900
135	West.	G	1200
100	Elec.Prods.		1200
55	El.Machry.	BRKT	1200

230 V.D.C. MOTORS

H.P.	Make	Type	Speed
200	West.	SK210	575
150	G.E.	L.C.	1750
100	Al.Ch.		1150
90/45	G.E.	RF-17	950/475
75	Sprague		1000/1500
75	G.E.	RC36	800
75	West. (2)	SK-180	475
75	Cr.Wh.	CMC	375/950
75	E-D	25S	450/1350
75	West.	SK151	250/1000
60	West. (3)	SK-160	680
50	G.E.	RC-12	1750
45/90	G.E.	RF-17	475/1950
50	West. (3)	SK-160	565
50	G.E.	CD	3600
50	G.E.	RF-17	250/1000
50	West.	SK	250/1000
40	West.	SK-103	1750
40	Century	DN-454	1740
40	G.E.	RC-31	1700
40	G.E.	RC-32	1100
40	G.E.	RC-34	750
40	G.E. (2)	CD-1441	400/1500
40	Cr.Wh.	CCM	700
40	Rel.	461T	400/1200
35	West.	SK	250/1000
35	West.	SK-120	1150
35	G.E.	RLC	440/800
30	West.	SK	975
30	Cont.	D-103	850
30	G.E.	RC-33	775
30	West.	SA	500/1500
30	West. (2)	SK-143	575
25	G.E.	RC-15	1750
25	West.	SK-83	1750
25	G.E.	*CDM-77	1750
25	E.D.	10S	1500
25	Rel.	92T	1150
25	West.	SA	500/1500
25	West. (2)	SK-130	600
25	G.E.	RF-14	800/1200

115 V.D.C. MOTORS

H.P.	Make	Type	Speed
300	West.	SK	900
100	Cr.Wh.	CMC	900
50	G.E.	CD	1150
40	G.E.	CD-113	850
30	West.	S	600
25	G.E. (2)	CD	1800
25	West.	SK-103	1150
25	Cr.Wh.	CCM	750
25	West.	SA	600/1200
15	E.D.	7½S	650/1230
15	Cr.Wh.	CM	650
10	Al.Ch.		900
10	E.D.	7½S	425/1700

550 V.D.C. MOTORS

H.P.	Make	Type	Speed
765	G.E. (3)	MPC	1045/1350

AC GENERATORS

KW	Make	Type	Speed
180	G.E.	ATB	900
100	G.E.	ATB	360
50	F-M	GG	1200
15	G.E.	ASI	1200

AC GENERATORS
Driven by DC Motors

KVA	Make	D.C. Input	A.C. Output
62½	G.E.	230	240
50	Star	115	120
35	G.E.	230	220
31	Ideal	115	440
31	El. Machry.	230	440
18	G.E. (3)	230	120/240
10	Burke	115	120
7½	Hertner	115	440
6¼	G.E.	230	240
5	El. Spec.	115	110
1¼	Al. Ch.	230	110

600 V.D.C. GENERATORS

KW	Make	Speed
400	G.E. (4)	1200
325	G.E.	1200
30	Burke	1750
20	Reliance	1150

GENERATORS
250 V.D.C. Motor Driven

KW	Make	Speed
300	Elliott	1200
250	G.E.	1150
200	G.E.	1200
200	West. Roto-trol	1200
150	West.	900
100	Delco	1200
100	G.E.	700
75	G.E.	1200
40	Rel.	1750
42	ABC (2)	1200
30	G.E.	1200
25	G.E.	1200

125 V.D.C. Motor Driven

KW	Make	Speed
225	G.E. (2)	1200
150	West. (2)	1200
100	West. (2)	900
100	G.E.	1200
100	El. Machry.	1200
50	West. (2)	1150
30	G.E.	1150
30	L.A.	1450
25	El. Machry.	1150

GENERATORS
Low Voltage D.C.

Amp.	Make	Voltage
125	Hobart (8)	7½
1500	Century	24
2000	G.E.	24V
100	G.E.	30
1000	G.E.	33
150	Watton	40
1000	Chandeysson	40
200	G.E.	42
1500	G.E.	50
1500	Century	60
1500	G.E.	60
1000	G.E.	75

FREQUENCY CHANGERS AND GENERATORS

Size	Make	Output Frequency
150 KW	G.E.	150 cy.
154 KVA	G.E.	150 cy.
15 KW	G.E.	408 cy.
10 KW	G.E.	200/700 cy.
7½ KW	G.E.	408 cy.
3 KW	G.E.	408 cy.

ELECTRIC HOISTS

1000# Y & T—D.C.
1000# Thor—Air.
1000# Y & T—A.C. (2)
1000# Shepard—A.C.
2000# R & M—D.C. (3)
2000# C & M—D.C.
4000# Thor—Air
6000# R & M—A.C.

STARTERS—D.C.

1—600 H.P. 230V. West. magnetic.
150—New 230V. D.C. magnetic starters, from 5 H.P. to 75 H.P. C-H, G.E., etc.
40—New 7½ H.P. 230V. magnetic reversing.
1—800 H.P. West. 115V. magnetic.

TRAVELING CRANES

2 Ton Harnischfeger, 26' 3¼" Span

GUARANTEE
YOUR INVESTMENTS!

- LAND gives 1 year guarantee.
- All equipment listed in stock.
- You can see your machines run and tested under power before shipment.
- Complete shop facilities with thoroughly trained & experienced mechanics (many have been with us over 25 years).
- Responsible Organization — 41 years' experience.

Partial List ONLY

EST. 1910 — L. J. LAND INC. — 41st YEAR

156 GRAND STREET — Phone CAnal 6-6976 — NEW YORK 13, N. Y.

MOTORS - M.G. SETS - CONTROLS

NEW AND GUARANTEED REBUILT

DIRECT CURRENT
230 V.

Reconditioned and guaranteed

HP	RPM	Mfg.	Brgs.
150	250/1000	Rel	Sl.
50	500/1500	G.E.	Sl.
50	1150	Whse.	Sl.
40	400/1200	Rel (TE)	Ball
40	400/1600	Imper.	Ball
35	400/1200	Ideal	Sl.
30	250/1000	Whse.	S.Sl.
30	500/1500	Rel	Ball
30	700/1400	Rel (TE)	Ball
25	250/1000	G.E.	Sl.
25	400/1600	Whse.	Sl.
25	600/1350	Rel	Ball
25	690	Rel	Ball
25	1150/2300	G.E. (TE)	Ball
20	300/1200	Rel	Ball
20	500/1500	G.E.	Sl.
15	250/1000	G.E.	Sl.
15	400/1600	Whse.	Sl.
15	400/1200	G.E.	Sl.
15	575/1000	Rel	Ball
15	575/1725	L.A.	Ball
15	650/1650	G.E.	Sl.
15	700/1350	Rel	Ball
10	400/1600	Whse	Sl.
10	400/1650	Rel	Ball
10	600/1280	Rel (TE)	Ball
10	850	Rel	Ball
7½	200/1200	Whse. (TE)	Ball
7½	400/1600	Rel	Ball
7½	400/1600	Whse.	Ball
7½	600/1800	Rel (TE)	Ball
7½	1150	G.E.	Sl.
3	850/1700	Rel	Ball

NEW DIRECT CURRENT
230 volt-drip proof.

Qu.	HP	RPM	Mfg.	Frame
1	3	690/2660	G.E.	284
10	5	850/1700	G.E.	CD-66
5	7½	575/1725	G.E.	CD-77
1	10	575/2300	L.A.	4051

CRADLE TYPE DYNAMOMETER

225 HP, Whse, 250 v. DC, 300/2000 RPM, complete with Toledo automatic printing type scale and all necessary control.

NEW MAGNETIC SLIP RING CONTROLS

3—ALLIS 250 HP, 440 volt (125 HP, 220 volt) Reversing, 7 accel. steps, main line air ckt. brkr., fully magnetic, open or enclosed.

M-G SETS

KW	D.C. Volts	A.C. Volts	Mfg.
500	250	2300	G.E.
400	125/250	2300	Ideal
200	250	2300	Ridgeway
100	250	2300	G.E.
75	250	220/440	G.E.
30	250	440	Ideal
20	250	220/440	G.E.
3VS	250	220/440	Rel.

SYNCHRONOUS

HP	RPM	Volts	Mfg.	Type
650	128	2300	Whse.	Engine
400	900	2300	Whse.	80%
350	600	440	Whse.	100%
300	720	550	G.E.	80%
250	200	440	G.E.	100%
200	720	440	G.E.	100%
150	600	440	G.E.	100%
100	1800	2300	Whse.	100%
10	1800	220	Whse.	80%

SLIP RING

HP	RPM	Volts	Mfg.
400	900	2300	G.E. (new)
350	450	2300	Whse.
300	600	440	G.E.
200	450	2300	Burke
200	900	220/440	G.E. (new)
125	900	440	G.E. (new)
100	1200	440	G.E. (new)
75	1200	440	G.E. (New)
50	720	220	Whse.
50	900	220	G.E.
40	900	220	G.E.
7½	1800	220	Rel. (New)

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BOSWICK ELECTRIC CO.

WAlbridge 1195

P.O. BOX 55 — AKRON 9, OHIO

Ames Steam Engine (condensing) 22" x 24", 200 RPM, Engine No. 41708; 315 KVA Westinghouse A.C. Generator, No. 2193167, 3/60/2400 Volt, F.O.B. cars Mpls.....$3,000.00

150 HP, 3500 RPM, 2200 Volts 3/60 cycle, Allis-Chalmers Motor, Serial No. 2337CK, Type ARWA, S.B., F.O.B. Minneapolis .....$ 500.00

100 HP, 575 RPM, 2200 Volts 3/60 cycle, General Electric Slipring Motor, Serial No. 5196854, Type MT562, complete with drum control, starting duty grids and primary oil switch; F.O.B. Minneapolis $2,500.00

New 400 Amp., 15,000 Volt, 3 Pole gang operated, vertical pole mounting, fused **Schweitzer & Conrad disconnect switch.** Regular cost $1,152.00. Our cost.....$ 850.00

Immediate delivery

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PORTER ELECTRIC CO., INC.

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POWER PLANT EQUIPMENT

SPECIAL OFFERINGS

TURBO-GENERATORS

2—4000 KW, 2300 V., 150# Cond.
1—3500 KW, 2500 V., 150# Cond.
1—3500 KW, 4000 V., 150# Cond.
1—2000 KW, 4000 V., 150# Cond.
1—2500 KW, 480 V., 150# Cond.
1—2500 KW, 550 V., 250# Cond.
1—2000 KW, 550 V., 175# Cond.
1—1500 KW, 2300 V., 290# Cond.
2—1250 KW, 2500 V., 225# Cond.
1—1000 KW, 2500 V., 250# Cond.
1—1000 KW, 4150 V., 290# N.C.
2—1000 KW, 480 V., 180# Cond.
1—1000 KW, 480 V., 150# Cond.
1— 750 KW, 550 V., 175# Extr.
1— 750 KW, 2300 V., 175# Extr.
1— 500 KW, 2300 V., 175# Extr.
1— 300 KW, 2300 V., 150# Cond.
1— 300 KW, 2300 V., 290# N.C.
1— 150 KW, 2400 V., 150# N.C.

ENGINE GENERATORS

1—900 KW, 2300 V., Unit.
1—500 KW, 250 V., D.C., Unit.
3—375 KVA, 550 V., Unit.
1—312 KVA, 440 V., Unit.

REFRIGERATION UNITS

5—500 ton motor or turbine driven

BOILERS

2—50,000#, 500#
1—30,000#, 425#
1—25,000#, 150#
2— 500 HP, 200#
3— 500 HP, 400#
1— 438 HP, 200#
2— 400 HP, 150#
4— 150 HP, 150# Sa. Mr.

Write or wire for additional data and prints.

A. LEE ELLIS CO., U. S. Machy. Bldg., 140 Federal St., Boston 10, Mass.

THE BUYERS MUST BE SATISFIED—ALWAYS

16—UNUSUALLY FINE USED 60 KW DIESEL ENGINE GENERATOR SETS

Generators: 440 V AC — Engines: Model 6-71 GM Diesels

AVAILABLE IMMEDIATELY

DULIEN STEEL PRODUCTS, INC.

OF WASHINGTON

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POWER PLANT MACHINERY

STEAM TURBINE GENERATOR UNITS

3 Phase 60 Cycle

25,000 KVA General Electric condensing, 200 lbs. steam pressure, 530° FTT, 13,200 volts, with surface condenser.
12,500 KVA Allis-Chalmers condensing, 225 lbs. steam pressure, 550° FTT, 13,200 volts, with surface condenser.
6,250 KVA Allis-Chalmers condensing, 200 lbs. steam pressure, 500° FTT, 2300/4,000 volts, with surface condenser.
5,000 KVA General Electric non-condensing extraction, 600 lbs. steam pressure, 750° FTT, 125/150 lbs. extraction, 0-50 lbs. exhaust, 13,800/4000 volts.
5,000 KVA Westinghouse condensing double extraction, 400 lbs. steam pressure, 600° FTT, 125 lbs. and 20 lbs. extraction, 480 volts, with surface condenser.
3,750 KVA General Electric condensing, 150-250 lbs. steam pressure, 500° FTT, 2300/600 volts, with surface or jet condenser.
2,500 KVA General Electric condensing extraction, 200 lbs. steam pressure, 550° FTT, 20 lbs. extraction, 480 volts, with surface condenser.
2,500 KVA (2) General Electric condensing, 125 lbs. steam pressure, 2300 volts, with jet condensers.
1,875 KVA General Electric condensing, 150-250 lbs. steam pressure, 650° FTT, 2300 volts, with surface or jet condenser.
1,250 KVA General Electric condensing, 200-400 lbs. steam pressure, 650° FTT, 2300/4150 volts, with surface condenser.
1,250 KVA General Electric condensing extraction, 175 lbs. steam pressure, 450° FTT, 0-10 lbs. extraction, 2300 volts, with surface condenser.
1,250 KVA Westinghouse condensing extraction, 150-250 lbs. steam pressure, 600° FTT, 5-25 lbs. extraction, 480 volts, with surface condenser.
937 KVA Moore condensing extraction, 200 lbs. steam pressure, 600° FTT, 0-20 lbs. extraction, 480 volts, with surface condenser.
625 KVA Westinghouse non-condensing, 150-200 lbs. steam pressure, 600° FTT, 5-25 lbs. exhaust, 480 volts.
438 KVA Westinghouse non-condensing, 150-200 lbs. steam pressure 500° FTT, 5-25 lbs. exhaust, 2300 volts.

STEAM ENGINE GENERATOR UNITS

3 Phase 60 Cycle

750 KVA Allis-Chalmers-Ames vertical uniflow, 150 lbs. steam pressure, 5 lbs. exhaust, 2400/4160 volts.
625 KVA General Electric-Skinner horizontal uniflow, 150 lbs. steam pressure, 5 lbs. exhaust, 240 volts.
500 KVA Allis-Chalmers-Chuse horizontal Corliss, 150 lbs. steam pressure, 10 lbs. exhaust, 480 volts.
375 KVA General Electric-Skinner horizontal uniflow, 150 lbs. steam pressure, 5 lbs. exhaust, 480 volts.
250 KVA (2) General Electric-Skinner horizontal uniflow, 150 lbs. steam pressure, 5 lbs. exhaust, 2300 volts.

SPECIAL

NEW 2859 KVA HIGH FREQUENCY GENERATORS

120/240 Cycle

3—2000 KW 70% P.F. 2859 KVA New General Electric A.C. generators, 3 phase, 240 cycle, 4150 volts, type ATB-6, 4800 RPM. Can be operated at lower frequencies with proportionate reduced speeds.

DIESEL ENGINE GENERATOR UNITS

3 Phase 60 Cycle

1,675 KVA Fairbanks-Morse, 2400/600/480 volts, 300 RPM.
1,388 KVA McIntosh-Seymour, 2300 volts, 300 RPM.
900 KVA Fairbanks-Morse, 2400 volts, 257 RPM.
782 KVA Worthington, 480 volts, 327 RPM.
546 KVA Worthington, 480 volts, 327 RPM.
450 KVA (2) American Locomotive, 480 volts, 514 RPM.
312 KVA Superior, 480 volts, 360 RPM.
300 KVA Fairbanks-Morse, 480 volts, 257 RPM.

SPECIAL

1675 KVA DIESEL ENGINE GENERATOR UNIT

1675 KVA Fairbanks-Morse generator 3 phase 60 cycle 2400 volts, 300 RPM, direct connected to

1750 HP Fairbanks-Morse diesel engine, 2 cycle, 10 cylinders, Model 33E16, 300 RPM.

Complete with direct connected exciter, switchgear, and all auxiliaries as in operation.

This unit is a heavy duty base load type machine and is in excellent condition. It was installed new in 1942 and operated intermittently. The engine can be adapted for dual fuel operation and the generator can be re-connected for 480 or 600 volts.

STEAM BOILERS

1,000 HP Springfield, 120,000 lbs. steam per hour, 300 lbs. steam pressure, 600° FTT, stoker fired.
825 HP Combustion Engineering, 275 lbs. steam pressure, 525° FTT, pulverized fuel.
800 HP Springfield, 50,000 lbs. steam per hour, 250 lbs. steam pressure, 500° FTT, stoker fired.
720 HP (2) Combustion Engineering, 60,000 lbs. steam per hour, 450 lbs. steam pressure, 600° FTT, stoker fired.
540 HP Keeler, 250 lbs. steam pressure, pulverized fuel or oil fired.
529 HP Babcock & Wilcox, 25,000 lbs. steam per hour, 160 lbs. steam pressure, 350° FTT, wood fired.
400 HP (2) Titusville, 25,000 lbs. per hour, 240 lbs. steam pressure, 500° FTT, stoker fired.
350 HP (2) Wickes 300-350 lbs. steam pressure, 600° FTT, oil and gas fired.
300 HP (2) Keeler 10,000 lbs. steam per hour, 250 lbs. steam pressure, 500° FTT, stoker fired.
225 HP (2) Babcock & Wilcox, 12,000 lbs. steam per hour, 200 lbs. steam pressure, 450° FTT, hand fired.
225 HP (2) Erie City HRT, 150 lbs. steam pressure, oil fired.
150 HP (3) Bros HRT, 125 lbs. steam pressure, stoker fired.

FREQUENCY CHANGER

3,750 KVA General Electric generator, 3 phase 60 cycle 2300/4000 volts, direct connected to 4200 HP General Electric synchronous motor, 3 phase 25 cycle 440/22,000 volts, 300 RPM.

Write, Wire or Phone for Further Details and Prices

INTERNATIONAL POWER MACHINERY CO.

UNION COMMERCE BLDG. **Telephone: MAin 1-9514** **CLEVELAND 14, OHIO**

BREW-WOLTMAN OFFERS

TURBINE UNITS

1—12500 KVA Allis Cond. 60 cy. 13800 V. 300-lb.
1—10000 KVA G.E. Cond. 25 cy. 6600 V. 290-lb.
1— 6250 KVA Allis Cond 60 cy. 4000 V. 175-280-lb.
1— 5000 KVA West. Extr. Cond. 60 cy. 480 V. 385-lb.
1— 3750 KVA G.E. Cond. 60 cy. 2300 V. 185-lb.
1— 2500 KVA Worthington Non-C. 60 cy. 2300 V. 150-200-lb. 40-lb. BP
1— 2500 KVA G.E. Extr. Cond. 60 cy. 480 V. 185-200-lb. steel valve chest.
2— 2250 KVA G.E. Cond. 60 cy. 240-400-lb.
1— 1875 KVA G.E. Cond. 2300 V. 60 cy. 180-lb.
1— 1563 KVA G.E. Cond. Extr. 60 cy. 2300 V. 200-lb.
1— 1250 KVA Allis Cond. 60 cy. 2300 V. 150-200-lb.
1— 1250 KVA Elliott Cond. 60 cy. 480 V. 150-200-lb. 600' Surface Condenser
1— 938 KVA G.E. Extr. Cond. 60 cy. 240 V. 200-lb.
1— 750 KVA G.E. Extr. Cond. 60 cy. 480 V. 200-lb.
1— 625 KVA G.E. Non-C. 60 cy. 2300 V. 180-lb. 35-lb. BP
1— 625 KVA West. Cond. 60 cy. 480 V. 150-lb.
2— 250 KVA Elliott Non-C. 60 cy. 208 V. 200-lb. 5-lb. BP

DIESEL ENGINE UNITS

1—1000 HP Superior 2300 V. 60 cy.
1— 900 HP Amer. Loco. 250 V. DC
3— 650 HP Amer. Loco. 440 V. 60 cy.
1— 600 HP Fair. Morse 2400 V. 60 cy.
1— 250 HP Buckeye 240 V. 60 cy.

STEAM ENGINE UNITS

1—312 KVA Skinner Uniflow 480 V.
1—250 KVA Ames Vertical Uniflow 480 V.
2—187 KVA Ames Vertical Uniflow 240/480 V.
1—156 KVA Ames Vertical Uniflow 240 V.

ROTARIES—60 CY.

QU.	KW	MFR.	VOLTS-DC	TRANS.	RPM
1	3250	G.E.	225/265	13800	300
1	2000	A.C.	600	4150	514
2	1000	West.	600	4150	720
3	1000	G.E.	600	13200	900 Auto.

SPECIAL

1—150 HP General Electric synchronous cubicle motor starter, type CR-7011, across-the-line, reversing dynamic breaking.

MERCURY ARC RECTIFIERS

QU.	KW	KIND	DC VOLTS	TRANS.
2	4500	Multi Anode	600	13800
4	3230	Ignitron	650	33000
2	1850	Ignitron	360	33000
1	1000	Ignitron	600	13800

MOTOR GENERATOR SETS—60 CY.

QU.	KW	MFR.	VOLTS-D.C.	A.C.	RPM
2	1500	G.E.	600	13200	720
1	1500	G.E.	250	2200	514
1	1000	G.E.	600	13200	514
1	750	A.C.	275	440	720
1	750	A.C.	250	2300	514
1	500	West.	125	2300	720
1	400	G.E.	250	6600	720
1	75	West.	125	440	1200

SYNCHRONOUS CONDENSERS

QU.	KVA	MFR.	VOLTAGE	RPM
1	2500	G.E.	2400/4160	720
1	2000	West.	2300	720
1	1500	G.E.	4600	900
1	1500	West.	2200	900

SYNCHRONOUS MOTORS—60 CY.

QU.	HP	MFR.	VOLTAGE	RPM
1	4350	Cr. Wh.	13800	514
2	700	West.	2300	200
1	600	G.E.	440	360
2	350	G.E.	2300	257
1	300	G.E.	2300	600
1	300	West.	2300	900

FREQUENCY CHANGERS

QU.	KVA	MFR.	CYCLES	RPM
1	3125	G.E.	25/60	300
1	3000	G.E.	60/25	300
2	2500	G.E.	25/62½	750
1	2450	G.E.	62½/25	750
1	1250	G.E.	25/60	300
1	1250	West.	25/60	300
2	1000	G.E.	25/60	300
1	500	A.C.	25/60	300

TRANSFORMERS—60 CY.

1— 7500 KVA	G.E.	138000—41000, 3 ph.
3— 3333 KVA	West.	132000—7620/13200 Y
1— 2000 KVA	G.E.	69000—13800/23900, 3 ph.
3— 1000 KVA	West.	66000—7200
3— 500 KVA	G.E.	66000—2400
1— 2500 KVA	G.E.	59/73 KV—5 taps, 3 ph.
3— 75 KVA	G.E.	44000—2300/4600
3— 8333 KVA	West.	43980—13900
3— 100 KVA	Wag.	36000—7200/12470 Y
1—18750 KVA	A.B.B.	34840—11000, 3 ph.
2— 7500 KVA	Al. Ch.	33000—13800, 3 ph.
3— 200 KVA	Wag.	33000—7200
6— 200 KVA	G.E.	33000—2300/4900
3— 167 KVA	G.E.	33000—2300/4000 Y
6— 150 KVA	G.E.	34500—2300/4600
4— 150 KVA	G.E.	33000—7200/12470
6— 75 KVA	Mol.	33000/16500—2300/4900
3— 75 KVA	Wag.	33000—7200/12470 Y
6— 50 KVA	G.E.	33000—2300
1— 7500 KVA	G.E.	26400—612, Rectifier Type
4— 450 KVA	Al. Ch.	25410/44000—13280/23000
1— 3000 KVA	G.E.	22000—480, 3 ph.
1— 2000 KVA	G.E.	22000/11000—2300, 3 ph.
1— 1000 KVA	G.E.	22000/11000—2300, 3 ph.
3— 833 KVA	G.E.	22900—480
3— 333 KVA	G.E.	22000/11000—2400
4— 750 KVA	Wag.	19050/33000 Y—6900/11950
3— 750 KVA	West.	13200—440
3— 333 KVA	G.E.	13200—240/480
2— 200 KVA	G.E.	11500—220/110
3— 200 KVA	Mol.	11000—2300
4— 833 KVA	G.E.	7620/13200 Y—2300
3— 500 KVA	G.E.	4000—2300
3— 200 KVA	West.	2400—120/240/480
3— 200 KVA	A.C.	2400—120/240
3— 150 KVA	G.E.	2400—240/480
3— 100 KVA	Kuhl.	550—220/110
12— 15 KVA	Stand.	450/25—117/234

OIL CIRCUIT BREAKERS

4—600 A.	154 KV	G.E.	FHKO-33-2500	Outdoor
1—600 A.	132 KV	G.E.	FHKO-80-1500	Outdoor
2—600 A.	73 KV	G.E.	FHKO-138-1000	Outdoor
1—400 A.	73 KV	G.E.	FHKO-236-500	Outdoor
1—600 A.	37 KV	G.E.	FHKO-139-450	Outdoor
1—400 A.	37 KV	G.E.	FHKO-236-500	Outdoor
4—600 A.	15 KV	G.E.	FHKO-139-750	Outdoor
4—600 A.	15 KV	G.E.	FLO-18-250	Outdoor

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We stock REBUILT gearmotors up to 60 HP

We stock NEW gearmotors and can ship from stock up to six weeks on most popular sizes.

3 phase 60 cycle 220/440 volt NEW GEARMOTORS in stock

1 HP 280 rpm with C-H brake
1 HP 473 rpm
1 HP 520 rpm
2 HP 45 rpm
2 HP 230 rpm
3 HP 20 rpm T.E.F.C.
3 HP 45 rpm
3 HP 84 rpm
3 HP 420 rpm
5 HP 280 rpm
5 HP 520 rpm
7½ HP 280 rpm
7½ HP 520 rpm
10 HP 190 rpm
15 HP 350 rpm

Quantities in most ratings
Also some 550 volt ratings

Electric Motors, Generators, Transformers, Grids, Gearmotors, Speed Reducers, Compensators, Drum Switches

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COMPLETE

STEAM POWER PLANT

5—714 HP Combustion Engineering WATER TUBE BOILERS, with Ebasco Superheaters, Sturtevant High Pressure Economizers, Green Chain Grate Stokers, Hagan Combustion Controls, Copes Feed Water Regulators, Clarage Forced Draft Fans, with Hoppers, Automatic Coal Conveyors, Automatic Ash Conveyor, 36" x 24" Jeffrey Flex-Tooth Coal Crusher.

1—705 HP Stirling 4 dum BOILER with B&W U-type superheater.

1—10,000 KW Allis-Chalmers STEAM TURBINE.

1—7,500 KW Allis-Chalmers STEAM TURBINE.

1—7,500 KW General Electric STEAM TURBINE.

All with complete control equipment.

Send for complete inventory in Denver.

MORSE BROS. MACHINERY COMPANY

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FOR SALE

Diesel Engine Superior type KNA 500 HP. 514 RPM directly connected to a 300 KW Westinghouse DC Generator. Can be purchased as one unit or separately.

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Teaneck 6-5325

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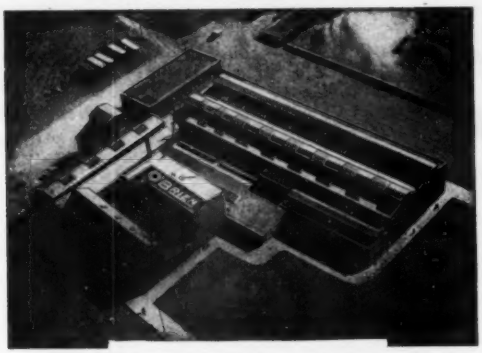

AERIAL VIEW OF THE O'BRIEN MACHINERY PLANT

MOTOR GENERATOR SETS
Philadelphia Stock

1—1000 K.W. Westinghouse 250 volt Flat Compound 500 RPM 1440 H.P. West. Syn. Motor .8 P.F. 3/25 cycle 2300 V. A.C. & D.C. Panels Modern Unit—Can furnish 60 cycle 2300 or 13200 volt.

1—600 KW G.E. MPC—2400 amp. 230 volt 514 RPM with 1050 H.P. G.E.—ATI Syn. Motor .8 P.F. 2 phase, 60 cycle, 2300 volt A.C. & D.C. Panels—Can furnish 3 ph. 550 V. or 2300 V.

2—500 KW Westinghouse 250 Volt 900 RPM with 720 H.P. West. Syn. Motors 3/60/2300/13200 volt, Serial #8130447-48 (year 1935)

1—500 K.W. Crocker Wheeler CCD, 250 volt 720 RPM with 750 KVA Cr. Wh. Syn. Motor 3/60/2300 V. A.C. & D.C. Panels—Like New.

1—450 K.W. G.E. Type CY-225 (1941 year) 250 volt 1200 RPM direct connected 650 HP GE-ATI-Syn. Motor 3/60/480 volt. Magnetic Red. Voltage Starter.

3—300 K.W. West. 3 wire 125/250 Volt 1200 RPM Generators (1938 year). Can furnish with suitable motor as single unit or as 600 K.W. 3 Unit Set. Advise Requirement.

1—300 K.W. Elliott 250 Volt 1200 RPM with 500 H.P. Syn. Motor 3/60/2300/1200 RPM—Automatic Controller & D.C. Panel.

2—150 K.W. G.E. Type MPC—250 Volt 1200 RPM 3/60/2300/200 H.P. Syn. Motor Drive A.C. & D.C. Panels.

1—150 K.W. West. SK 184, 3 wire 125/250 Volt 1200 RPM (1938 yr.) 250 H.P. West. Syn. .8 P.F. 2/60/220 or 3/60/220/440/550/2300 V.

1—100 K.W. Al. Chalmers 250 Volt 1200 RPM 150 H.P. Syn. Motor 2/60 or 3/60 any voltage.

1—100 K.W. G.E.—C.D.—125 Volt D.C. 150 H.P. GE Syn. Motor, 3/60/220/440/1200 RPM.

1—75 K.W. BURKE 250 Volt 900 RPM 113 H.P. Burke—Syn. M.D. 2 phase any voltage.

1—50 K.W. West. SK—240 Volt with West. Syn. M.D. 3/60/220/440/1200 RPM.

Smaller Sizes and Types—Advise Requirements.

ELECTRIC MOTORS

Q.	H.P.	Make	Type	Volts	Speed
1	1200	Cr. Wh.	Sl. Rg.	2300	257
1	700	G.E.	ATI (syn)	480	1200
2	600	West.	Syn.	440	257
3	500	West.	CS	2300/6600	514
3	500	E.M.	Syn.	2300	1200
1	400	G.E.	Syn.	2300	450
1	400	West.	CW	440	514
1	350	G.E.	MT18	2300	400
1	315	G.E.	Syn.	2200	720
1	250	West.	CS	2300	1200
1	250	West.	CS	440	450
2	200	E.M.	Syn.	2300	1200
1	200	West.	Syn.	2300	1200
1	200	West.	MW	440	600
1	150	Ideal	Syn.	220	1200
1	125	West.	CS	440/2300	1800
1	125	West.	Syn. (3 brg.)	550	600
1	125	Cent.	SC	440	1800
1	100	G.E.	K	220/440	1200
1	100	A.C.	Sl. Rg.	440	720
1	100	G.E.	IM	440	600
2	100	G.E.	Syn.	440	300
1	75	West.	CW	440	1200
1	60	West.	CW	440	720
3	50	A.C.	SC	220	900
1	50	West.	CS	440	3600
1	50	West.	CW	220	900
2	50	Cent. (new)	SC	220	1200
1	40	G.E.	MT536	440	900
1	30	G.E.	MT532	440	900
2	25	G.E.	MT332	440	900

CENTRIFUGAL PUMPS

Q	GPM	TNH	Description	Size	HP	Speed
2	10,000	200'	LeCourtenay	20"	624	870
2	10,000	100'	LeCourtenay	20"	350	870
1	10,000	114'	De Laval	18"	370	988
1	9,000	88'	De Laval	18"	250	870
2	8,150	132'	LeCourtenay	16"	350	1150
1	8,000	110'	Worthington	14"	500	1200
2	7,000	200'	LeCourtenay	16"	423	1000
2	6,500	160'	Worthington	14"	200	1200
1	6,000	110'	Ingersoll-Rand	12"	500	1200
2	5,000	125'	Worthington	14"	200	1200
1	4,000	110'	Ingersoll-Rand	12"	500	1200
1	3,500	47'	Southwark	12"	75	870
1	3,100	42'	Worthington	12"	50	1150
2	2,550	200'	De Laval	8"	200	1750
1	2,310	24'	Worthington	12"	20	860
2	1,700	95'	De Laval	10"	60	1750
1	1,500	231'	Allis-Chalmers	8"	150	1750
3	1,200	40'	Worthington	6"	15	1750
1	550	125'	Lawrence	4"	30	1750
1	350	65'	Lawrence	4"	10	1150
1	275	172'	(new) Weil	3"	20	1750
2	150	100'	(unused) Worth.	2"	10	1750
1	45	120'	Gould	1½"	3	3450
1	30	115'	Worthington	1½"	2	3450

AIR COMPRESSORS

1—12,000 CFM Ingersoll-Rand Turbo Compressor, 3.25# pressure, 250 HP, 3/60/440/3600 RPM.

1—8,000 CFM Cooper-Bessemer 150/440 PSI, direct motor 2700 HP syn. 3/60/2300 volt new.

1—1690 CFM Sullivan 100 lb. Class WN2, 12x12½x16 two stage syn. motor 250 H.P., 3/60/2300 volt, exciter, starting equipment.

1—1050 CFM Ingersoll-Rand ES1, 17¾x13, 50 lb. PSI, 275 RPM, V-belt.

1—880 CFM Worthington Syn. motor drive 150 H.P. 3/60/440/277 RPM, size 17x10½x12.

1—734 CFM Sullivan Angle Class W13, Single Stage 13x13x8, 60 lb., 300 RPM, V-belt, 100 HP.

2—528 CFM Chicago NSB, 100 lb., 285 RPM V-belt 14x12.

2—368 CFM Ingersoll ER-1, 285 RPM, 100 psi., 50 HP direct gear, M.D. 3/60/220.

1—360 CFM Schramm Vertical V belted on steel base, 75 HP motor 3/60/220

3—300 CFM Schramm Vert. Direct connected 50 HP GE 3/60/220-440/1200 RPM on base (1945)

1—277 CFM Chicago PB4 Air Cooled 50 HP V-Belt Motor Drive.

1—254 CFM Chicago Pneumatic NSB-125# Belt Drive 40 H.P.

1—245 CFM Ing. Rand 10x10 ER-1, 125#.

1—215 CFM Penna. 3A 10x8, 50 lb.

2—173 CFM Ingersoll ER-1 9x8, 300 RPM, 100 LB., V-belt.

TURBO GENERATORS

1—750 KVA G.E. Extraction 3/60/2300 volt, 250 PIS, 80 lb. & 16 lb. Extr. Surface Condenser. New 1940.

1—625 KVA G.E.-Moore 3/60/2300/3600 RPM Non-Condensing 180 PSI 35 lb. B.P. New 1936.

1—500 KVA West. Non-Cond. 3/60/220/440, 150 PSI 10 lb. B.P.

3—300 KW West. Non-Cond. Direct Current, 250 volt, 150 lb. 10 lb. B.P. New 1938.

1—75 KW G.E. Non-Cond. D.C. 125 volt.

1—35 KW G.E. Non-Cond. D.C. 125 volt.

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TRANSFORMERS—60 Cycle

Qu.	KVA	MAKE	TYPE	Ph.	VOLTAGES
1	1500	GE	Pyranol	3	4150x2300V
1	500	Kuhl.	OISC	1	4600x2300V
3	400	GE	H	1	6900x2250V
1	300	Pitts.	ODSC	1	7800x440V
1	200	GE	HT	3	2300x220
1	200	Whse.	Auto	3/3	4150x2300
1	200	Pitts.	OISC	1	4000x110/220
1	200	GE	Auto	3/2	4150x2400
1	150	GE	HT	3	4150-120/208Y new
1	150	GE	KS	1	2300x230
1	100	Pitts.		1	2750x110/220
3	100	Wagner	RCKV	1	240x120/120
2	100	Whse.	SK	1	4400x220/440 Taps
2	100	Newark	Dry	3/3	440x220
3	50	Whse.	Interteen	1	2400x120/240

MOTOR GENERATOR SETS
3 Phase, 60 Cycle

Qu.	KW	MAKE	SPEED	DC	AC
1	1000	GE	514	600	2300/4150 Syn.
1	300	GE	1200	250	2300 Syn.
1	150	GE	1200	125/250	2300 Syn.
1	150	Whse.	600	125	4150 Syn.
1	125	CW	1200	125	2300 SC
1	100	CW	1200	125	220/440 SC
1	100	El. Mach.	1200	125	4150 Syn.
3	94	GE	1200	60	440 SC
2	40	El.Mach.	1750	125	440 SC

SYNCHRONOUS

300 HP El. Mach. 720 RPM 2300 V T.E.F.C. outdoor Service.
200/100 HP Whse. 720/360 RPM. 4150 V.

SLIP RING

1	2500	GE	MT	6600	257
1	250	Whse.	CW	440	600
1	200	Whse.	CW	440	600
1	100	GE	IM	440	400
1	75	GE	MT	220	200 Vert
1	75	GE	MT	440	1800
1	60	GE	MT	220	1750
1	60	GE	MT	440	900
1	50	GE	MT	220	1720
1	50	GE	MT	220	1200
1	50	Whse.	CW	220	900
1	50	GE	MT	220	1700
1	50	GE	MT	220	600
1	40	GE	MT	220	1200
1	40	GE	MT	2200	1200

SPECIAL—WELDING MOTOR GENERATOR SET

1—176 KVA Whse. Welding Gen. Set, 1 Ph. 220V, 800 Amp 57% PF with Slip Ring Motor & Exciter

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MACHINERY at REDUCED PRICES

BOILER

Water Tube. Babcock & Wilcox, 1945. 2 Drum. Bent Tube. Economisers. Internal Desuperheater. Superheaters: W.P. 400 P.S.I. Hydrostatic Press. 718 P.S.I. Heating Surfaces: 2441 sq. ft. Superheater 350 sq. ft. Economiser 1620 sq. ft. 3 Todd "Hex Press" Fuel Oil Burners. Diamond Soot Blowers. Auxiliaries available.

BOILER

Mfr. Vancouver Iron Works, Vancouver, B. C. Type: Yarrow, 3 Drum. Bent Tube. Water Tube. Oil fired. 4 Burners. 55,000 lbs. steam per hr. Max. Heating Surface 6256 sq. ft. Working Press. 225 P.S.I. Test Press. 387 P.S.I. Built 2/7/43.

NUMEROUS OTHER ITEMS ARE AVAILABLE

MILNOR & BLEIGH STS. • PHILA. 35, PA.
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COMPLETE DIESEL PLANT

3—575 HP F.M. 5 cylinder, 400 RPM. 383 KW F.M. 3/60/2300 alternators. Woodward governors, heat exchangers and complete plant auxiliaries. For sale in whole or part. Condition excellent.

MISSISSIPPI VALLEY EQUIPMENT CO.
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ELECTRICAL CABLE

- for every Industrial and power application
- Special constructions. Odd lengths.
- Large stocks on hand of high voltage, lead covered cables not ordinarily stocked by your regular suppliers.
- Cut to length. Reasonably priced.

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EXCELLENT POWER UNITS

2—125 KVA Westinghouse AC generators, 440 Volts, 277 RPM. Powered by 2 Bruce Mac Beth gas/gasoline engines.

1—150-HP, 225 RPM, Synchronous motor. Real Bargains.

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B & W PULVERIZERS

3—Type E-32 practically new Coal Pulverizers, complete with 75 H.P. motors, blowers and all equipment. Used approx. 2 years. Purchased new 1943.

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Diesel, Steam Turbine, Engine
GENERATORS
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UNUSED — RECONDITIONED
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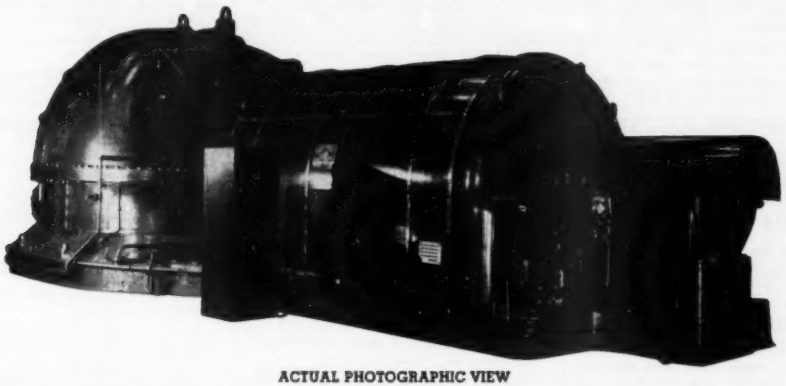
25,000 KVA—20,000 KW, 80% P.F., 3 phase 60 cycle, 13,200 volts, 1800 RPM General Electric Company condensing turbine generator unit 215 P.S.I.G. 540-550° total temperature complete with direct connected shaft exciter, switchboard and instruments, a 30,000 square foot 2-pass Westinghouse surface condenser, motor driven and turbine driven pumps and condensing accessories.



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TURBINE-GENERATOR UNITS

3 phase, 60 cycle

6250 KVA G.E. condens., 3-stage, 2300/4000 volts, 200# P.S.I., 600°TT.
3750 KVA Allis condensing 2300 volts 125 to 175 PSI.
2500 KVA G.E. Type ATB, Form HT, 2300/480 volts, 3600 RPM, two bearing alternating current generator LESS TURBINE.
2500 KVA G.E. condensing 200 P.S.I. 2400/600/480 volts.
1875 KVA Westinghouse condensing, 2300 volts, 250# PSI.
1563 KVA G.E. condensing 2300 volts 225 PSI.
780 KVA Allis condensing, 150 PSI, 480 volts.
740 KVA Allis non-condensing 2300/480 volts, 150 PSI, 12# back.
625 KVA G.E. condensing 150 PSI 480 volts.
625 KVA G.E. non-condensing 150 P.S.I., 20# back, 480 volts.
125 KVA G.E. non-condensing, 150-200 P.S.I., 2300 volts.
125 KVA Westghse. non-condensing 150/250 P.S.I., 2400 volts NEW.

Direct Current

300 KW Westghse. 3-wire, 250 volt 150/250# P.S.I. non-condensing.
150 KW (2) Westinghouse-Worthington, 250 volts, 3-wire, 225-250 P.S.I. condensing.
100 KW (2) G.E. 125 volt, 200/275 P.S.I. non-condensing
75 KW (2) Westinghouse-Moore, 120 volt, 200# P.S.I. condensing.
60 KW (3) new Westinghouse, 120 volt, 200# P.S.I. condensing.

MOTOR GENERATOR SETS

100 KVA Westghse. 60 cycle, 2400 volts, 900 RPM alternator direct connected 135 HP, 250 volt direct current motor.
62½ KVA G.E., 60 cycle, 2300 volt alternator to 75 HP, 125 volt DC motor.
10 KW G.E. 125 volts direct current to 12 HP 60 cycle, 220 volt motor.

SYNCHRONOUS MOTORS

5000 KVA Westinghouse, 4000 volt, 720 RPM Electrical Syn. (condenser).
900 HP Allis, 2200 volts, 150 RPM.
300 HP G.E., 80% P.F., 2300 volts, 720 RPM.

JULY BARGAINS
SPECIALLY PRICED

1—3000 CFM, 55 PSI 34"x36"-16"x36" Allis-Chalmers horizontal cross compound 150# pressure steam driven air compressor.
2—Elliott Company twin-strainers mounted on factory bedplate to a 25 HP, 3 phase 60 cycle, 220/440 volts 1170 RPM General Electric totally enclosed fan cooled motor with miscellaneous piping and valves, practically new.
1—4400 sq. ft. Worthington surface condenser.
2—1000 GPM, 1270 foot head, 4-stage Morris pumps each connected 417 HP, 390# P.S.I. non-cond. G.E. turbine.
1—G.E. Bank of Scott connected 2 to 3 phase, 60 cycle transformers, 2500 KVA capacity.
1—20 KW 125 volt direct current generator connected Hill Diesel engine.

UNAFLOW GENERATOR UNITS

Alternating Current—3 phase, 60 cycle

750 KVA G.E. 2300/440 volt generator direct connected Skinner non-condensing engine.
500 KVA G.E., 2400/480/240 volts generator connected Ames Vertical Engine, 150#.
375 KVA G.E., 2300/440 volts generator connected 23"x24" Skinner Horizontal Engine.
175 KVA Westghse., 240 volt generator connected Skinner Horizontal Engine, 125-150# P.S.I., 5# gauge back.

Direct Current

400 KW G.E. 250 volts, 360 RPM generator connected Skinner vertical engine 150#.
300 KW Burke 250 volt generator connected Skinner horizontal engine 125#.
250 KW Crocker Wheeler 125 volt generator direct connected Ames Vertical non-condensing engine 150#.
250 KW (2) G.E., 3-wire, 250 volts generators connected Skinner engines, 150#.
25 KW (2) Allis 250 volt, 500 RPM generators each direct connected American Blower vertical engine 125/150#.
15 KW, 120 volt generator connected Troy Engberg engine 12½#.

UMC UTILITIES MACHINERY CORP.
1965 EAST 6th STREET • CLEVELAND 14, OHIO • Long Distance 422

MOTORS • GENERATORS • TRANSFORMERS

7x7 AIR COMPRESSOR

Ingersoll Rand 7x7 Class ERI—100#—with or without drive.

1—400 KW Westinghouse 500 V. DC 750 RPM 800 Amps. Motor—580 HP. Synchronous 3 Ph. 25 cycle 440 V. 750 RPM.

ANODIZING M.G. SET

33 KW Gen. Elect. Type BR. Form C 60 V. DC. Direct connected to 50 HP. 3/60/440/1800 Gen. Elect. Motor.

600 HP GEAR REDUCER

1—600 HP Farrel-Birmingham Herringbone Gear Unit. Type SL. Size 30/16 Speed 730 RPM to 115 RPM.

400 HP GEAR REDUCER

1—400 HP Nuttall (Westinghouse) Type LMR-25 Single Helical Heavy Duty Reducer—6-1 Ratio at 900 RPM with High Speed Shaft Extension for Brake.

400 HP SYNCH. MOTOR

1—400 HP Westinghouse Synchronous Motor. 3/60/2300/900 RPM. Unity P.F. with direct connected exciter—Late Type.

MOTORS

60-50-25 Cycle in Stock—All Sizes. Slipring—Squirrel Cage—Synchronous. All types of Control Equipment.

100 HP Westinghouse Slipring 3 Bearing 3/60/220/440/435 RPM.

100 HP Gen. Electric Type I form K 3/60/2300/600 RPM.

100 HP Gen. Electric Type KT 356 3/60/2200/900 RPM.

125 HP Gen. Electric Type I form K 3/60/440/720 RPM.

125 HP Gen. Electric Type KT 3/60/2300/1200 RPM.

150 HP Gen. Electric Type KT 3/60/440/500 RPM.

150 HP Gen. Electric Type I form K 3/60/2300/720 RPM.

150 HP Gen. Electric Type I form K 3/60/2300/900 RPM.

200 HP Gen. Electric Slipring Type I form M 3/60/440/600 RPM.

200 HP Gen. Electric Type KT 3/60/440/600 RPM.

250 HP Gen. Electric Type KT 3/60/440/720 RPM.

350 KW GENERATORS

2—350 KW General Electric Generators Type MPC, 250 Volt DC, 720 RPM Single Bearing Machines.

MOTORS

250 HP Gen. Electric Synchronous Type ATI 3/25 cycle/2200/500 RPM.

350 HP Westinghouse Slipring Type CW, 3/25 cycle/2200/500 RPM.

400 HP Westinghouse, Synchronous 3/60/2300/900 RPM.

DC CIRCUIT BREAKERS

1—1000 AMP. Condit. 2 Pole

1—1600 AMP. Condit. 2 Pole

1—1600 AMP. Westinghouse 2 Pole

1—3000 AMP. Westinghouse 2 Pole

125 VOLT DC MOTORS

1—100 HP Crocker Wheeler 125 Volt DC 850 RPM Ball Bearing

1—150 HP Crocker Wheeler 125 Volt DC 850 RPM Ball Bearing.

Will make 1200 RPM 125 Volt Generators.

REBUILT TRANSFORMERS

3—100 KVA G.E. 1 ph., 60 cy., 2400/4160 pri., 120/240 sec.

3—1667 KVA Wagner 1 ph., 25 cy., 23,000 pri., 575 sec.

ERIE ELECTRIC CO., INC. 124 CHURCH ST. BUFFALO, N. Y.
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SPECIAL OFFERING!

Good Used Diesel Engines

10—GM Quad units (each quad consists of 4-Model 6-71 Diesel engines). *Available at Seattle Yard.*

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30—GM Twin units (each twin consists of 2-Model 6-71 Diesel engines). Available for Delivery from Seattle, Portland, Oakland, Los Angeles.

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DULIEN STEEL PRODUCTS, INC.
OF WASHINGTON
9265 E. MARGINAL WAY SEATTLE 8, WASH.

DIESEL POWER PLANT

FOR IMMEDIATE DELIVERY — EXCELLENT CONDITION

300 KW Generator DC 550/275 Volts. 450 HP Atlas Engine 360 RPM. Complete with switchboard, air starting tanks, miscl. equipment, spare parts, tools, etc.

Equipment can be seen operating. Any reasonable offer will be considered.

THE POWER AUTHORITY
ST. THOMAS, VIRGIN ISLANDS, U.S.A.

EQUIPMENT FOR SALE

2—500 hp straight tube W.T. Boilers 165 psi. Detroit U. F. stokers.

1—Nordberg Uniflow engine, 18 x 24 direct connected to a-c generator 200 kw 240/3/60.

1—Filer & Stowell 24 x 42 Corliss 100 rpm with 12 ft. x 41 in. belt wheel. 100 ft. 3 ply 38 in. leather belt like new.

2—Duplex Steam B. F. pumps.

3—Oil switches—Condit Electrical Mfg. Co. Boston. Type D17A Max volts 15,000—400 amps.

3—200 kva 60 cycle 1 phase Polarity sub—Pri Volts 3810. Sec volts 244-488. GE type H Form C.P. Rebuilt by W. N. Abbertson & Co. Inc. Ser. 554242, 55-4243, 554244.

Westinghouse static condensor, type L.D. Normal operating volts 4000, Max. sustained volts 4400. Normal kva 180 Max. kva 218. 60 cycle 3 phase S.O. 33C808.

32—Capacitors Type LD 5 kva Style 420525.

3—Westinghouse current transformers. Type KA 50 VA 50-5 amps. Comp for 25 VA 8800 V 25-133 cycle Style 180-643A.

Westinghouse hand operated oil circuit breaker. Style 296783B.

J. GREENEBAUM TANNING CO.
4763 N. 32nd St. Milw. 16, Wis.

FOR SALE

Power plant equipment. Steam, Diesel, electrical, boilers, engines, turbines, generators, new or used.

PENN MACHINERY COMPANY
Jackson, Miss.

ELECTRIC MOTORS AND GENERATORS

WAGNER CERTIFIED REBUILT

BACKED BY 45 YEARS OF QUALITY AND SERVICE

For QUALITY • SERVICE • PRICE - "Check with WAGNER First!"

OVER 45 YEARS OF EXPERIENCE is back of every machine sold by Arthur Wagner Company. Large stocks and modern facilities insure ample choice and prompt service at reasonable cost. All Wagner "Certified Rebuilt" equipment conforms to standards approved by National Industrial Service Association. Inspect our shop and stock—see why it pays to . . . "Check with Wagner First!"

M-G SETS

KW	Mfr	Input V	Output V
500	Whse.*	2200/440 AC	250 DC
300	G.E.	440 AC	275 DC
200	Whse.*	2300 AC	275 DC
200	Gen. Elec.*	220/440 AC	125 DC
150	Gen. Elec.*	2300/440 AC	600 DC
150	Cr. Wh.*	220/440 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	Allis Ch.* (2)	2200/440 AC	60 DC
100	Whse.	230 DC	220 AC
100	Whse.	220/440 AC	230 DC
100	Gen. Elec.	220/440 AC	125 DC
100	Gen. Elec.	220/440 AC	250 DC
75	Gen. Elec. (2)	220/440 AC	250 DC
75	Gen. Elec. (3)	220/440 AC	125 DC
65	Whse.	220/440 AC	250 DC
60	Gen. Elec.*	220/440 AC	60 DC
50	Allis Ch. (2)	220/440 AC	125/250 DC
50	Gen. Elec.	220/440 AC	250 DC
45	Cr. Wh. b.b.	220/440 AC	125 DC
40	Whse. (2)	220/440 AC	125 DC
40	G.E.	220/440 AC	250 DC
35	Cr. Wh. b.b.	220/440 AC	125 DC
35	G.E.	220/440 AC	48 DC
25	Gen. Elec.	220/440 AC	250 DC
25	G.E. b.b. New	220/440 AC	125 DC
300	Allis Ch.	2200/440 AC	125/250 DC

*Syn. motor drive.

D.C. MOTORS

HP	Mfr	Type	Volts	Speed
150	Cr. Wh. TEFC	83H	230	890
100	Whse.	8K181	230	450/900
100	Gen. Elec.	C	230	875/1000
100	Gen. Elec.	CD125	230	850
75	Whse (2)	8K163	230	850
75	Gen. Elec.	RC	230	1000
75	Northw'n	K20	230	1750
60	Cr. Wh.	50H	220	700
60	Reliance b.b.	651T	230	750
50	Cr. Wheeler	CMC	230	1750
50	Gen. Elec.	R.C. 14	250	1050
40/60	Whse.	8K160	230	500/1000
40	Gen. Elec.	RC-32	230	1150
40	Cr. Wheeler	EH	230	1750
40	Whse.	8K110L	230	1750
40	Whse (2)	8K130	230	950
35/50	Gen. Elec.	CD125	230	575/1150
30	Whse.	8K110L	230	1150
25/30	Cr. Wh. b.b.	FH	230	575/1725
25	Whse.	8K150	230	300/1200
25	G.E. (2)	CD93	230	1150
25	G.E. b.b. New	CDM93	115	1150
25	Century b.b.	DN	230	1150
25	Gen. Elec.	RF13	230	250/1000
25	Gen. Elec.	CD105	230	500/1500
20	Gen. Elec. (2)	CD85	230	1750
20	Whse. (2)	8K113	230	500/1500
20	Gen. Elec.	RC31B	230	850
20	Gen. Elec.	BF12	230	400/1600

- **EXPLOSION PROOF MOTORS—**
- **GEARHEAD MOTORS, AC & DC.**
- **FREQUENCY CHANGERS.**
- **CIRCUIT BREAKERS, AC & DC.**
- **SPEED REDUCERS.**

D. C. GENERATORS

KW	Mfr	Type	Volts	Speed
300	Allis Ch. New	MECW	125/250	1200
300	Gen. Elec. 1 brg.	DMC	275	720
150	Cr. Wh. b.b.	83E	250	1150
105	Century b.b.	1500 amp	70	1200
100	Gen. Elec.	CD	250	1200
100	Gen. Elec.	C	250	750
100	Gen. Elec.	DLC	125/250	675
75	Gen. Elec.	RC	250	1200
75	Gen. Elec.	RC36	125	1200
65	Whse.	8K160	250	1100
60	Gen. Elec.	LC	250	700
50	Allis Ch. (2)	KW	125/250	1200
50	Gen. Elec.	R.C. 14	250	1200
50	Cr. Wheeler	50H	250	900
45	Cr. Wh. b.b.	FH	125	1750
40	Whse.	8K	250	1200
35	Gen. Elec.	CD	250	1200
25	G.E. b.b. New	CDM93	125	1450

A. C. MOTORS—25 CYCLE

HP	Mfr	Type	Volts	Speed
275	G.E. synch.	ATI	440	750
150	Whse.	HF	440	500
60	Allis Ch.	ARY	440	1500
50	Gen. Elec. int.	MTC5337	440	750
50	Gen. Elec.	I-K	440	750
30	Gen. Elec.	MT343	440	750
25	Howell	SR	440	750

A. C. GENERATORS — 60 CYCLE

KVA	Mfr	Type	Volts	Speed
625	Gen. Elec.	ATB	2300	450
625	G.E. 25 cycle	ATB	2300	750
500	Allis Ch.	3 brg.	240/480	360
300	Gen. Elec.	ATB	600	720
275	G.E. 25 cycle	ATI	480	750
250	Whse.	G	2400/480	600
225	Gen. Elec.	ATB	240/480	600
187	Gen. Elec.	ATB	240/480	900
156	Elec. Machy.	3 brg.	240/480	514
125	Gen. Elec.	ATB	240/480	720
125	Gen Elec.	ATB	240/480	300
75	El. Machy.		2300	900
75	Gen. Elec.	ATI	240/480	1200
56	Gen. Elec.	ATB	240/480	1200
56	Gen. Elec.	ATB	240/480	900
31	Whse. b.b.	late	120/208	1200

A. C. MOTORS — SLIP RING
3 Phase 60 Cycle 220 or 440 Volts

QU	HP	Mfr	Type	Speed
1—	600	Gen. Elec.	I-M	360
1—	500	G.E. 3 brg.	I-M	450
1—	400	Gen. Elec.	I-M	514
1—	330	Whse. 2200V.	CW	450
1—	300	G.E. 2300V.	I-M	1800
1—	250	G.E. 2200V.	IM-17A	600
1—	250	Allis Ch. 2200V.	ANY	514
1—	250	Cr. Wheeler	SR	600
1—	200	Cr. Wheeler	SR	600
1—	200	Gen. Elec.	I-M	360
1—	150	G.E. 2200/4000V.	I-M	1200
1—	150	Gen. Elec.	I-M-17	450
1—	150	G.E.	IM-16	600
1—	150	G.E. 2200/440V.	I-M	720
2—	125	G.E. New	M-6333	900
1—	125	G.E. New b.b.	M-6325	1200
2—	100	G.E. New	M-6324	1200
2—	100	Gen. Elec.	I-M	1800
1—	100	G.E. Vertical	MT353	1200
1—	100	Northwestern	HW75A	900
1—	100	Cr. Wheeler	SR	600
1—	100	Northwestern	HW	1800
1—	75	G.E. 2200V.	MT356	720
1—	75	Whse. 2200V.	CW	800
2—	75	Gen. Elec.	MT343	1800
1—	75	Whse.	CW	1200
1—	60	G.E. TEFC b.b.	M-6326	720
1—	60	Fair. Morse	BV	720
1—	60	Whse. 2200V.	CW716C	900
1—	50	Allis Ch.	ANY	900
1—	50	Howell	SR437	1200
1—	50	Gen. Elec. int.	ITC5013	600
2—	40	Whse.	CW636A	1200
1—	40	Allis Ch. b.b.	ART	1200
2—	30	G.E. 2200V.	MT332	900
1—	30	Gen. Elec.	MT332	1200
2—	30	Gen. Elec.	MT333	900
2—	25	Gen. Elec.	MT	900
3—	20	Whse. b.b. New	CW264	1800

A. C. MOTORS — SYNCHRONOUS

HP	Mfr	Type	Volts	Speed
600	Gen. Elec. (2)	TS	2200	514
300	Gen. Elec.	ATI	2300/550	450
300	Whse.	G	2200/440	600
300	Gen. Elec.	ATI	440	720
275	G.E. 25 cycle		220/440	750
220	G.E. 3 brg. .8PF	ATI	220/440	600
250	Gen. Elec.	TS	220/440	360
200	G.E.	TS	220/440	150
190	El. Machy.	3 brg.	220/440	514
150	Gen. Elec.	ATI	220/440	720
150	Gen. Elec.	ATI	220/440	300
125	El. Machy. (2)		220/440	1800
120	Burke b.b. .8PF	AC19	2200/440	1200
125	El. Machy.	B.B.	2400/4800	900
100	American b.b.	YGH	220/440	900
175	Whse.	2 brg.	220/440	360
90	Gen. Elec.	TS	220/440	1200

A. C. MOTORS — SQUIRREL CAGE
3 Phase 60 Cycle 220 or 440 Volts

QU	HP	Mfr	Type	Speed
2—	500	Fair. Morse 2200V.	BH	1200
1—	325	Gen. Elec.	KT420	400
1—	300	G.E. 2200V.	KTF541	1800
1—	300	Gen. Elec.	I-K	600
2—	250	Whse. 2200V.	CS	1200
1—	250	Gen. Elec.	FT540AZ	3600
1—	250	Gen. Elec.	IK-17A	450
1—	250	Gen. Elec.	IK-17	600
2—	200	Gen. Elec.	I-K	600
1—	200	G.E. 3 brg.	I-K	400
1—	200/112	G.E.	KF559	1200/900
1—	150	Ideal 2200V.	A-327	1800
1—	150	Gen. Elec. TEFC b.b.	K6333S	1200
1—	150	Gen. Elec. 2200V.	IK-E13A	1800
1—	150	Gen. Elec.	IK-17	450
2—	125	G.E. New b.b. HT	KG6324	1200
1—	125	Con. 2200V. b.b.	SC	1800
1—	125	F.M. 2200V. vertical	UH-16D	1200
2—	125	G.E. 2200V. TEFC	K6326	3600
2—	125	Reliance b.b. New	5053S	1800
2—	100	Gen. Elec.	KT356	900
2—	100	Gen. Elec.	I-K	1200
1—	100	Gen. Elec.	I-K	720
1—	100	Gen. Elec. b.b. NEW	K5048	1800
1—	75	Fair. Morse b.b.	HJQ	600
1—	75	Reliance b.b. NEW	C8084	900
2—	75	Reliance b.b. NEW	C505	1800
1—	75	G.E. TEFC 2200V.	K-6325	900
2—	75	Gen. Elec.	KT343	1200
2—	75	Gen. Elec.	I-K-14	600
1—	75	G.E. Expl. Pf.	K6325	1200
2—	60	G.E. Vertical	KT336	1200
1—	60	Gen. Elec.	I-K	600
3—	60	G.E. 2200V.	KT333	1800
1—	60	G.E. hi torq	KG5304	1200
2—	60	Reliance b.b. NEW	B5504	1800
1—	60	Reliance TEFC NEW	C505	1200
1—	50	Rel. TEFC New	B4458	1800
2—	50	Gen. Elec.	KT346	720
1—	50	Gen. Elec.	KT356	450
2—	50	G.E. Vertical	KT546	720
2—	50	Reliance b.b. New	CC504U	900
2—	50	Whse.	CS	1200
1—	50	G.E. NEW b.b. HT	KG495	1800
2—	50	Reliance b.b. NEW	C445	1200
1—	50	Whse. bialip	WL507	900
1—	50	Allis Ch. 2200V.	AR445	1800
1—	250	Gen. Elec.	I-K	720
2—	200	Reliance b.b. New	B6085S	1800
1—	150	G.E. TEFC	K6336	3600
1—	150	Whse.	CS	720
2—	125	Rel. TEFC New	B6085S	1800
1—	125	G.E. b.l. New	K6324S	1200
1—	100	Rel. TEFC New	5053S	3600
1—	75	Rel. TEFC New	5048	3600
1—	75/90	Gen. Elec.	I-K	3600
1—	75	Wagner	22VRM	1200
1—	50	Fair. Morse b.b.	HJ-12D	900
2—	50	Gen. Elec.	KT527	1800
2—	40	Master b.b.	PA405	1800
1—	40	Louis Allis b.b.	OX404	3600
2—	40	Gen. Elec.	KT332	1200
4—	40	Gen. Elec.	KT336	900
2—	40	Gen. Elec.	KT346	600

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SQUIRREL CAGE MOTORS
3-Ph., 60-Cy.

Qu	HP	Make	Type	Volts	RPM
1	400	G.E.	IK	2300	514
1	400	G.E.	KT-412	2200	435
2	300	Whse.	CS-890	2300	1785
1	250	Whse.	CS	2200	1160
1	200	Whse.	CS-873C	2200	1160
1	200	Al.Ch.	AR	440/220	580
2	125	Al.Ch.	AR	2200	1750
1	125	Whse.	CS-761C	440/220	1750
1	125	C.W.	126-Q	440/220	430
2	100	Whse.	CS-685C	440/220	1750
1	100	G.E.	IK	440/220	1800
1	100	Al.Ch.	AR	2200	1180
1	100	Al.Ch.	AR	550	690
1	100	F.M.	H241B	440/220	435
1	100	Whse.	CS-938	2200	495
1	78	G.E.	I-K15	440/220	570
1	75	Al.Ch.	AR	2200	1765
1	75	Al.Ch.	AR	2200	1750
1	75	Al.Ch.	AR	2200	690
1	80	G.E.	KT	440/220	1160

SYNCHRONOUS MOTORS
3-Ph., 60-Cy.

Qu	HP	Make	PF	Volts	RPM
1	3000	Whse.	80	4800/2400	720
1	700	G.E.	80	2300	720
1	600	Whse.	80	2400	720
1	400	Whse.	80	440	690
1	300	Whse.	80	440	514
1	268	Al.Ch.	100	2200	900
1	150	G.E.	100	2200	900
1	150	G.E.	100	550/2200	690
1	150	G.E.	80	550/2200	450
3	125	El.Mchy.	100	4800/2400	900
1	125	G.E.	80	2200	900
2	100	Whse.	80	440/220	1800
1	100	Whse.	100	2200	1200
1	100	Ideal	80	220/440	900
2	100	G.E.	80	220/440	600

SLIP RING MOTORS—CONSTANT DUTY—3-Ph., 60-Cy.

Qu	HP	Make	Type	Volts	RPM
1**	3000	G.E.	MT	2200	356
1**	1200	C.W.	SR	2200	237
2**	1000	Al.Ch.	ANY	2200	235
1**	600	G.E.	MT-20	2200	360
1	500	Whse.	C.W.	4600/2300	514
1	500	Al.Ch.	ANY	4000/2300	514
1**	400	G.E.	IM	2300	590
1**	400	Al.Ch.	ANY	2200	514
2	500	G.E.	I-16-M	2200	450
2	400	G.E.	MT-412	2200	450
1	300	G.E.	I-15-M	2200	1200
1	300	Al.Ch.	ANY	2200	514
1	250	G.E.	MT-414	2200	300
1	200	G.E.	I-16-M	2200	585
1	150	G.E.	I-13-M	2200	1750
1***	125	Whse.	CW-870	2200	870
1	100	F.M.	H20C	440/220	900
1	75	G.E.	IM	440/220	695
1	75	Whse.	CW-7540	440/220	690

**Mill type pedestal bearing. ***3 bearing.

MOTOR GENERATOR SETS

Qu	KW		Make	RPM	Volts DC	Volts AC
1	2400	3U	Al.Ch.	720	625	4800/2400
1	1500		Whse.	514	250	4600/2300
2	1000		G.E.	514	575	4000/2300
1	500	3U	Whse.	1200	120/240	2300/440
2	500		C.W.	720	575	4000/2300
1	500		C.W.	720	250/275	4000/2300
1	500		C.W.	720	250/275	2300/440
1	350		G.E.	720	250	2300/440
1	200		Ridgway	900	250	2300
1	155		G.E.	720	250	2300/440
1	150		Al.Ch.	1200	250	2300/440
1	150		G.E.	1200	500	2300/440
1	100		Ridgway	1200	275	4000/2300
1	85		C.W.	1200	250	2300/440
1	75		Star	1200	230	440/220
1	75		Al.Ch.	900	250	2300
1	50		Burke	1800	240	440/220
1	30		Reliance	1800	250	440/220
1	25		Whse.	1200	120/240	440/220
1	20		Reliance	1800	250	440/220

(3U—3-unit set.)

TRANSFORMERS (Power)

Qu	KVA	Make	Type	Phase	Voltage
1	7500	G.E.	H	3	33000/29700–13800/12600
1	4500	G.E.	HT	3	27000/24300–2300
3	1500§	Gregory	(X)	3	4160–480
2	750§	Gregory	(X)	3	4160–480
3	250	Packard	OISC	1	13200–2200
3	150	G.E.	H	1	19000/9500–550/2200
3	100	Whse.	SS	1	12075/10955–230/460
3	100§	G.E.	HS	1	14400/12870–240/480
3	50	Al.Ch.	OISC	1	22000–220
2	50	Wagner	HS	1	13200/11880–575/287
3	50	Penna.	OISC	1	2400/4160-Y-120/240

(X) New, selfcontained, indoor type, air cooled.

DIRECT CURRENT MOTORS

Qu	HP	Make	Type	RPM
1***	3000	Whse.	Encl.(Rev.)	600
1***	2400	Whse.	Encl.(Rev.)	600
4***	1500	Whse.	Encl.(Rev.)	600
4***	1200	Whse.	Encl.(Rev.)	600
4***	800	Whse.	Encl.(Rev.)	600
1	350	G.E.	CD-169	1150
1	325	Whse.	QM-660.6	450/900
1	200/250	El.Dy.	622	400/1200
1***	200	G.E.	MPC	500/1200
1	200	Whse.	Mill	300/1200
1	300	Whse.		240/300
1	180	G.E.	MPC	400
2*	150	C.W.	83-H	890
1***	125	Whse.	SK-190	600
1	100/125	Rel.	1095-F	300/1200
2	100	Rel.	1056-F	400/1200
1	90/160	G.E.	MPC	625/1125
1*	50/75	Rel.	1095-F	300/1200
1	35	G.E.	RF-14	500/1600
1	35	G.E.	CD-125	400/1200
1	35	G.E.	CD-147	300/1200
1	35	Rel.	35P	250/1000
1	32½	Whse.	SK-150	400/1200
1*	30/75	Whse.	SK-151L	400/1200
1	30	Al.Ch.	E-145	400/1200
1	30	G.E.	CDM-105	875/1750
2	27½	El.Dy.	158	450/1350
1	25	G.E.	RF-13	400/1600
1	25	G.E.	CD-123	400/1200
1	25	Whse.	SK-140	400/1200
1	25	Whse.	SK-111L	250/1000
2	20	Al.Ch.	E-130	400/1200
3	20	G.E.	CD-123	300/1200

All above 230-VDC except where marked ***.
*** Pedestal bearing mill design 525/600-VDC.
(Rev.) Designed for mill reversing service.
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2—1900 HP Stirling type Boilers 250#—super
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5—510 HP; 2—315 Heines 165# several 200 HP
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Also smaller Boilers & Fire Tube Boilers

TURBO UNITS

2—10,000 KW Turbo-Generator—Cond.
1— 7,500 KW Turbo-Generator—Cond. 600#
1— 5,000 KVA Turbo-Generator 450# with condens.
2— 3,000 KW Turbo-Generator—Cond.
2— 3,000 KW Turbo-Gen. and Cond., one aut. extrac.
2— 2,500 KW Turbo-Generators and Condensers
3— 2,000 KW Turbo & Condenser
2— 1,500 KW Turbos & Condenser
2— 1,250 KW Turbos & Condenser
2— 1,000 KW, also 750 & 500 KW Units, Condens.
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MODERN 1000 KW Turbo-Generator

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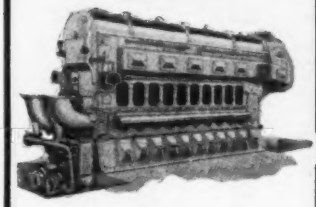


FAIRBANKS-MORSE

Model 38-D-8-1/8

10 CYL.—Opposed Piston

Direct Reversible Engine

GENERATORS

DIESEL

25 • 30 • 60

100 • 200 • 750

1000 KW AC

20 • 50 • 100

KW DC

TURBOS

150 KW DC 120 V

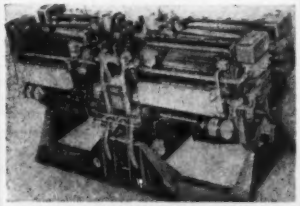
•

200 KW DC 120 V

•

500 KW AC 450 V

(ONE ONLY)



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800/1600 AMPERE ARC WELDING MOTOR GENERATOR SETS

Each set consists of two generators and one motor, mounted on base. Each Generator: Northwestern Type K20DR, 800 ampere, 50 volts, 1750 RPM. Motor: 125 HP, Allis Chalmers, Type AR, 2200 volts, 3 phase, 60 cycle, 1750 RPM.

SLIP RING MOTORS—3 Ph., 60 Cy.

Qn.	HP	Speed	Volts	Make	Type
6	7½	810	550	G.E.	MTC-5301
2	10	1140	440	West.	HF-7A
3	10	570	220	G.E.	HI-11
2	11‡	820	550	G.E.	ITC-5008
3	15	1150	440	West.	CW-464C
2	15	570	220	West.	CW-646
1	18	680	440	West.	MW-316
1	20	580	440	West.	CW-638
1	25	1130	550	G.E.	MT-323
2	25	350	220	Wagner	BR
2	25	720	440	Wagner	22VBR
1	30	865	440	West.	CW-646
1	30	350	440	G.E.	MT-332
1	30	675	440	G.E.	MT-336
2	35	600	440	F-M	HV-H16A
2	40	585	2200	Al.Ch.	ARY-223C
1	40	560	440	G.E.	MT-346
2	50	1150	440	G.E.	M-536
1	50	860	440	West.	HF-12A
1	50	570	440	G.E.	MT-552
1	53‡	550	220	G.E.	10C-5013***
1	60	695	440	West.	CW-758
1	60	570	550	G.E.	MTC-5546
1	60	345	550	West.	CW-938
1	80‡	575	440	G.E.	MTC-5352
2	125	430	440	G.E.	IL-16
2	150	1750	440	G.E.	MTP-549
1	175	503	550	West.	CW-1002
1	200	495	2200	G.E.	IM-17A
1	250	600	2300†	G.E.	IM-17
3	300	900	140	G.E.	IM-17
2	300	880	2200	G.E.	IM-17A
4	350	1775	2300	G.E.	IM-E15A
2	350	880	2200	G.E.	IM-17A
1	400	505	550	West.	CW
1	600	1770	440	G.E.	IM-E15C
1	650	360	440	G.E.	MT-442Y
1	700	735	4000‡‡	West.	CW

220 volt motors can be reconnected for 440 volts.
‡Intermittent rating. ***2 phase.
**New. ‡‡25 cycle.
†Also 440 or 550 volts. *Also 440 or 2300 volts.

A.C. GENERATORS — NEW

3 Phase, 60 Cycle, 0.8 P.F., Two Bearing, with Damper Winding & Direct Connected Exciter.

Qn	KVA	RPM	Make	Volts
4	18.7	1800	Columbia	240/120
4	18.7	1800	Columbia	208/120

230 VOLT CONST. SPEED D.C. MOTORS

Qn.	HP	Speed	Make	Type
10	3	850	Reliance	Y-23T
25	2½	850	West.	SK-30
1	7½	1150	G.E.	CDM-66
3	7½	850	G.E.	CD-75
10	10**	1750	Kimble	BA-324
5	10**	1150	Al.Ch.	EB-80
2	10	850	West.	SK-83
10	13½**	600	West.	SK-93
3	15	1750	G.E.	CD-75
5	15	825	West.	SK-90
1	20	1750	L.A.	ONA-L851
1	20**	1450	G.E.	CDM-83
1	20	1750/1310	West.	SK-83
2	20	1140	G.E.	RC-30
1	20**	1450	G.E.	CDM-38
11	20	750	West.	SK-110L
17	25	825	West.	SK-120
1	30	1100	G.E.	RC-12
1	40	1700	West.	SK-103
1	40	750	G.E.	RC-34
1	50	750	West.	SK-150
1	50	850	G.E.	RC-16
1	60	1750/1310	West.	SK-143
1	150	700	Al.Ch.	
2	200	1150	G.E.	RC-38
1	250	1150	C.W.	CMC-101A

230 VOLT ADJ. SPEED D. C. MOTORS

Qn.	HP	Speed	Make	Type
6	5/7½	600/1800	G.E.	RA-30
1	10	600/1600	Reliance	T-92T
1	12½	230/340	West.	SK-130
10	12½**	600	West.	SK-93
1	15	600/1200	West.	SK-100L
1	20	500/1500	G.E.	RF-11
1	20/25	100/1200	West.	SK-153
1	25	400/1600	G.E.	RF-13
1	25	500/1500	G.E.	RF-12
1	25/29	300/1200	G.E.	RF-13
1	30	400/1200	West.	SK-163
1	30/40**	400/1600	G.E.	CD-1236
1	35	500/1500	West.	SK-143
1	40/50	400/1200	Reliance	T-4611
1	75	500/1500	Cr.Wh.	CCM
1	75	375/750	Cr.Wh.	
3	100	225/900	G.E.	MPC-125M
5	100	400/1200	Al.Ch.	
1	100	220/960	West.	SK-200
1	125	450/1000	West.	SK-190
1	175	230/500	West.	SK-220
2	375	350/500	G.E.	MPC

SQUIRREL CAGE MOTORS—3 Ph., 60 Cy.

Totally Enclosed Fan Cooled, Ball Bearing

Qn.	HP	RPM	Volts	Make	Type
2	5	1750	440	L.A.	JA-254
8	5	1730	440	G.E.	K-254
4	7.5	1740	440	G.E.	K-284
1	10	1735	440	West.	CS-324
1	10	1140	440	Wagner	CP2-326
1	15	1745	440	West.	CS-328
1	15	1175	440	L.A.	JA-365
1	20	1760	220	G.E.	K-364
1	25	1200	550	G.E.	K-405
1	25	1170	220	L.A.	JX-405
1	25	705	440	West.	CS-W504
1	40	3545	440	G.E.	KF-4058

SPLASHPROOF, BALL BEARING

Qn.	HP	RPM	Volts	Make	Type
23	5	1750	440	L.A.	PS-254
1	5	1735	220	G.E.	K-254
1	5	1160	440	L.A.	FX-284
1	15	1175	440	L.A.	JA-365
4	15	1150	440	L.A.	FX-365
2	40	1175	220	G.E.	K-445
1	50	1760	440	L.A.	FX-445A
8	50	1160	220	G.E.	K-504
1	150	1775	440	L.A.	FX-1168
3	150	880	440	L.A.	FX-1368
1	150	700	440	G.E.	KF-6335

OPEN TYPE MOTORS

Qn.	HP	Speed	Volts	Make	Type
1	15	3485	220	Reliance	AA-B3247
5	15**	1733	440	Century	SC3/8
1	15	1200	220	G.E.	KT-502
1	15	900	220	G.E.	FTR-512
1	20**	3475	220	West.	CS-326
5	20**	1750	440	Wagner	RPI-364
1	20	1750	220	West.	CS-W364
1	20	1200	220	G.E.	KF-513
2	20	1160	440	West.	CS-464C
2	20	900	220	G.E.	FTR-522
1	25	1800	220	G.E.	KT-312
5	25**	1740	440	Century	SC-364
1	25	1160	440	West.	CS-667C
1	25	900	220	Howell	SCRB-356***
2	25**	875	440	Master	PB-403
2	25	575	440	G.E.	KT-542
3	30	3550	550	G.E.	K-3648
1	30	1755	220	G.E.	FT-513
1	30	1160	440	West.	CS-644
1	30	870	220	West.	CS-646
1	40**	3545	220	G.E.	KF-4048
2	40	1750	440	West.	CS-563C
2	40	900	2300	G.E.	FTR-536
4	50**	1750	440	Wagner	RPS-405
1	50	850	220	West.	CCL
2	60*	1750	440	Ideal	AH-444
2	60	900	440	G.E.	KT-346
1	75	1160	440	West.	CS-862C
4	75	870	220	West.	CS-766A
2	75	865	2300	G.E.	KT-352
1	100	690	220	West.	C
1	100	580	2200	G.E.	1K-15A
2	100	500	2200	West.	CS-930
1	100	495	2200	Al.Ch.	AN
1	125	435	440	Al.Ch.	AR
2	125	400	2300	G.E.	1-17-FR
1	200	580	550‡‡	G.E.	KT-5648
2	300	587	2200	West.	CS-39A
1	500	1200	140	G.E.	KTP-567
1	700	1800	2300/4000	West.	CS-4-39D-12

220 volt motors can be reconnected for 440 volts.
**New. ***2 Phase. ‡‡Reconnectable for 440 volts.

G. E. DYNAMOMETER

Cradle Type, with control and Dial Scale. (Write for Complete Specifications.)

Qn.	HP	DC Volts	RPM	Type
1	200	250	1200	C

MOTOR GENERATOR SETS

125 and 250 Volts D. C.

(Write for complete Specifications)

KW	Make	RPM	DC Volts	AC Volts
2	Cont.	1750	125	220/440
7.5	West.	1455	125	220/220§
10	West.	1750	125	220/440
10	West.	1450	125	220/440†
10	West.	1150	250	220/440
15**	G.E.	1800	125	220/440
15	G.E.	1755	250	220/440
15	West.	1450	125	220/440§
16	West.	1750	125	2200/440
25	G.E.	1200	125	220/440
30	Al.Ch.	1750	125	220/440
50	G.E.	1720	125	220/240†
75	G.E.*	1200	125	220/240

Note: 3KW, 5KW & 7.5KW, 250V Sets Available
**New. *Synch. Motor Driven. §50 Cy. 125 Cy.

Above Items Represent a Partial Listing Only. Your Inquiries Will Receive Our Prompt Attention. All Equipment is Located in Our Cleveland Warehouse. We have Controls for Most Items Listed.

ELECTRIC GENERATOR & MOTOR CO.

4521 HAMILTON AVE. CLEVELAND 14, OHIO

PARTIAL LISTINGS OF EQUIPMENT AVAILABLE FOR YOU

MOTOR GENERATOR SETS

3 Ph. 60 cycle

KW	DC Output	AC Input	Speed	Make
800(3U)	600/600	2300	1200	Whse.
750	500	13200	900	Whse.
400	250	220/440	1200	G.E.-Whse.
300	250	440	900	G.E.-E.M.
100	250	440	1200	G.E.
100	250	4300	1200	Whse
75	125	440	1200	G.E.
50	125	440	1800	C-W
50	250	220	1200	A-C-Whse.
47½	125	2200	1200	A-C
25	230	220	1000	Rel.-G.E.
22	125	220	900	A-C
20	125	220	900	G.E.-A-C
12½	230	220	1800	Whse.
10	250	220	1800	Whse.
7½	250	220/440	1800	Whse.
7½	125	220/440	1200	Whse.
5	230	440	1200	Whse.
1	115	220/440	1800	G.E.

ROTARY CONVERTERS

KW	DC Volts	AC Volts	RPM	Make
1700	250	*	514	G.E.
300	600	33000	1200	Whse.
150	230	*	1200	Whse.

*Will wind for any voltage.

SYNCHRONOUS MOTORS

3 Phase, 60 Cycles

HP	RPM	Volts	Mfr.
3000	720	4800	Whse.
735	600	12000	G.E.
500	514	440	G.E.
435	720	2300	G.E.
430*	750	2300	Whse.
320	900	2300	G.E.
300	1800	2300/4160	G.E.
300	720	440	Whse.
250**	225	2200	G.E.
225	900	4100	G.E.
200	277	2300	Whse.
200**	150	220	G.E.
175**	225	220	G.E.
160	600	440	G.E.
160	164	440	G.E.
150	1800	2200	G.E.
150	1200	220	Whse.
150	900	440	Star
150*	300	220	Chandeyson
120**	225	220	E-M
115	164	220	G.E.
115	164	220	G.E.
100	1800	2200	Whse.
100	1200	220	Whse.
95	1200	220	Burke
75	1200	220/440	Delcof
75	900	2300	G.E.

*25 cycles.
**Rotor and stator only, engine type.

SPECIAL

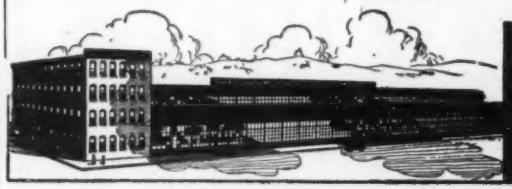
3—G.E. Rectifiers, 500 amp., 6 volt, DC output 440 Volt, 3 Phase, 60 Cycle input, New Copper Oxide Stacks.

SLIP RING MOTORS

3 Phase, 60 Cycles

HP	RPM	Volts	Mfr
500	900	440	G.E.
500*	900	2200/4160	G.E.
500*	900	2200/4160	G.E.
375	1800	2300	A-C
350	514	220/440	G.E.
300	1200	440	Whse.
300	720	2200	A-C
300	600	440	G.E.
250	600	440	A-C
250	300	2200	A-C
235	1800	220	G.E.
200	1800	440	A-C
200	600	220	G.E.
100	1200	440	Whse.
100	720	440	A-C
100	600	440	G.E.
75	900	550	G.E.
75	720	440	A-C
75	600	440	A-C
60	1800	220/440	A-C
60	900	440	A-C
50	1200	220	F-M
50	900	440	Whse.
50	720	440	A-C
45	1200	440	Whse.
40	900	220	A-C
40	720	2200	A-C
40	600	220	G.E.
40	450	220	Triumph
35	900	440	G.E.
35	600	440	G.E.

*New.



GLOW ELECTRIC CO.
927 HARRIET ST. CINCINNATI 3, OHIO
PHONE MAIN 3024

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375 KVA - FOR SALE - 300 KW
WORTHINGTON-WESTINGHOUSE
INSTALLATION

COMMERCIALLY UNUSED

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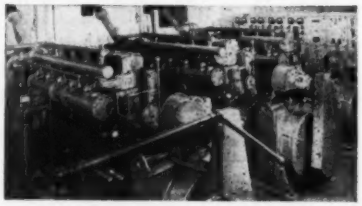
IMMEDIATE DELIVERY



Each Plant consists of

3 Worthington Model BB 5—150 HP Diesel Engine Generating Units direct connected to Westinghouse Generators.
Rated 100 KW—125 KVA—3 phase, 60 cycle, 460 Volts, AC Current at 600 RPM.
Suitable for reconnection to 85 KW—3/50/230/400 at 500 RPM.
Complete with all accessories and auxiliaries including evaporative coolers—switchboard—distribution panel.

OWNED & OFFERED BY

KANE-McGUIRE COMPANY
Single units available

1492 East 32nd Street
Brooklyn, New York
PHONE: WHitehall 3-6843

Steam Turbine Generator Set

1500 KW Allis Chalmers, 2300 Volts, Throttle Pressure 150 Lbs., Jet Condenser.

Excellent Condition

MARSHFIELD ELECTRIC & WATER DEPARTMENT
MARSHFIELD, WIS.

SELLING FOR CUSTOMERS

1—375 KVA—240/3/60 Westinghouse geared non condensing turbine.
2—37½ KVA—240 & 480/3/60 Cat. diesel sets.
1—50 KW—220 AC & 250 DC West. M.G. Set.
1—1000 HP—270 lb. Springfield boiler.

What do you need—what have you to sell—We have nationwide outlets to help you when buying or selling equipment.

H. BLANE JOHNSON & ASSOCIATES
53 W. Jackson Blvd., Chicago 4, Ill.

VERT. HYDRO ELEC. UNITS

5 units from 120-400KW exc. on top. Leffel wheels Wd.Wd. governors 2400 volts.
3 horiz. Pelton units 5000KVA for 425' head.
1 horiz. 240 KW for 250' head.
1 144 KW vert. 480 volts for 10-12' head.
2—15" Leffel scroll wheels 150-250' head.
1 400 KW horizontal alternator 2300 volts 180 RPM.

Many others. All subject to prior sale.

WM. C. MOULTON ASSOC., MONSON, MASS.

BOILERS

10 to 1000 H.P.

NEW-USED RECONDITIONED

Steam, Gas and Electric Power Equipment

J. PARKIE THOMPSON CO., INC.
507 FIFTH AVE., NEW YORK CITY
MURRAY HILL 7-6547-8-9

DRYER: Allis Chalmers single shell, 10 ft. x 90 ft., heavy duty, plate thickness 22.95 lbs. per sq. ft., complete with or without the following:

Coal fired furnace with Hoffman Pirate, Firete Stoker, with grates, buckstays, all necessary steel, etc.

Dust Collector, Western Precipitation Multiclone size 726.

Two size 25 Western scrubbers and spray eliminators.

Exhauster, Clarage #41, with or without 150 H.P., General Electric Motor, slip ring, type I, form M, 695 RPM, Serial No. 817360, 440 volt, 9 groove pulley.

One G.E. 200 H.P. Motor, 3 bearing type, 585 RPM, 2200 volt model MIN691, serial No. 1420792, 11 groove pulley.

One A.C. Control Panel.

One Drum Controller.

14—G.E. Resistor Boxes.

One Bristo Recorder model 431 Pyromaster.

One Leeds Northrup Recording Controller.

One Pug Mill or 12" dia. shaft paddle Mixer, 10'0" chain drive.

All located on Iron Range in Minnesota.

COMPRESSOR: Worthington 2 stage, 29/18-½x 21, 600 H.P. synchronous motor, 3 phase, 60 cycle, 440 volt, 180 RPM, 100 lbs. pressure, 3000 CFM, complete with auxiliary equipment. In operation new, available immediately.

DIESEL MOTOR: 122 H.P. Caterpillar D13000 complete with clutch, V-belt pulley, and spare parts.

DRAG SCRAPERS, CRESCENT BUCKETS: 1—Sauerman 2 yd. Drag Scraper outfit complete, without 75 H.P. motor. 1—Sauerman ¾ yd. capacity complete with 30 H.P. motor. 1—Sauerman 1 yd. capacity complete with diesel motor.

BOILERS: 1—Erie City 150 H.P., ASME, return tubular, 4" tubes, 150 lbs. working pressure, pin hole grates and all fittings. 2—220 H.P., 160 lbs. pressure, National Board, 3 drum, low head, complete.

CRUSHERS: Jeffrey 24x20 and one 24x42 Flextooth Crushers, suitable for metal turnings, coal, etc.

A. J. O'NEILL
Lansdowne, Pa.
Phila. Ph.: Madison 3-8300—3-8301

BOILER for sale

484 HP. Springfield 250#, 100°SH. Sectional Header, Excellent.

STEPHEN A. DOUGLASS CO.
630 Ft. Washington Ave. New York 33, N. Y.

MOTOR GENERATOR SETS

125 K.W. 250 Volt D.C. Burke 440 Volt 3 phase 60 cycle 900 RPM Synchronous Motor.

100 K.W. 250 Volt D.C. Gen. Elec. 3 brg. 440 Volt 3 phase 60 cycle 900 RPM. Synchronous Motor.

50 K.W. 125 Volt D.C. Westinghouse 3 bearing with 75 H.P. 220 Volt synchronous motor.

50 K.W. 250 Volt D.C. Westing. 4 brg. 220/440 Volt 3 phase 60 cycle 120 RPM motor.

20 K.W. 125 volt D.C. Allis Chalmers 3 brg. 440 volt 3 phase 60 cycle 1800 RPM motor.

ROTARY CONVERTERS

(2) 100 K.W. 2500 D.C. 1200 RPM Westinghouse with 2300 volt primary Transformers.

MOTOR REPAIR & MFG. CO.
1557 Hamilton Ave., Cleveland, Ohio

260 H. P. DIESEL ENGINE

Liquidation Sale—Twin 6 cylinder General Motors—Unit #12-587. With starting batteries and silencers. A Stand-by Unit used 4500 Hours.

MARTIN J. HANSON TRUSTEE
1500 N. Kostner Ave. Chicago 51, Ill.

here's the reason...

. . . YOUR INQUIRIES ARE PROMPTLY ANSWERED

FINGERTIP INFORMATION

Our staff is capable of providing you with information and specifications on all types of jobs. From the minute your job enters the door to the day it is shipped a "fingertip" record is kept to guide it through our plant. Our staff also keeps a running inventory of "stock-on-hand" and on available equipment throughout the country to assure fast and efficient fulfillment of your needs.

GUARANTEED REBUILT POWER EQUIPMENT

HERE'S A WIDE SELECTION FROM OUR GIANT STOCK

SQUIRREL CAGE MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2200 volts or higher)

H.P.	MAKE	TYPE	SPEED
1000	*G.E. (New)	KS437S	1800
750	*G.E.	KT	720
600	*A.C. (New)	AZ (TEFC)	3600
500	*G.E.	PBG	1800
500	*Fr.-Morse	HS	1200
450	*G.E.	KF-567S	1200
400	*Cont. (New)	NZ	1800
400	*A.C.	ARWW	900
300	*Westgh.	CS	3600
300	G.E.	IE-K	1200
300	A.C.	AR	900
300	Westgh.	CS	514
250	West. (New)	CS	1800
250	A.C. (New)	ARW	900
250	L. Allis	1468	725
250	Westgh.	CS	600
200	*G.E.	IK-13B	1800
150	G.E.	KT	1800
150	G.E.	KTP	1200
150	G.E.	IE	1800
150	*A.C. (New)	ARW	1800
150	Westgh.	CS950A	600
125	West. (New)	CS504	3600
125	*A.C.	AR226	1800
125	G.E.	KG326B (tefc)	1200
125	A.C.	AN	900
125	G.E. (New)	KG333	900
100	A.C. (New)	ARWWT	3600
100	*G.E.	FT542Z	1800
100	G.E.	FTRP	1800
100	*Westgh.	CS	1800
100	U.S. (Vert.)	CFU	1200
100	Westgh.	CS	1200
75	West. (New)	CS 505	1800
75	G.E.	KS05	1200
75	G.E.	KT348	1200
75	Ideal	AA350	720
75	G.E.	FT556	729
75	Triumph	TR18	514
75	G.E.	IK	600
75	G.E.	IK	514
60	Westgh.	CS504	1800
60	A.C. (New)	AR8230	900
60	A.C.	AR826F	514
50	G.E.	KT527	1800
50	U.S. (Vert.)	SCV937	1800
50	Westgh.	CS640	1800
50	Westgh.	CS504	1200
50	G.E.	KT343	1200
50	G.E.	KTP	1200
50	*G.E.	KT342	900

Hundreds of smaller motors!

DIRECT CURRENT MOTORS

230 Volts

H.P.	MAKE	TYPE	SPEED
1500	Westgh.		300/600
1000	Westgh.		400/800
400	Westgh.		600/1200
375	Westgh.	Ped	650
200	Westgh.	SK210	800
175	Reliance	14007	575
175	G.E.	ELC11	750
125	G.E.	Marine	1200
100	G.E.	RC34	2500
100	Westgh.	SK173	850
100	A.C.	E152	575
40	Cr.-Wh.	CMC	1750
40	G.E.	CQ2904	800
35	Cr.-Wh.	CM351	700
35	G.E.	C	900
30	Westgh.	SK120	975
30	Cr.-Wh.	CCM	450
30	Westgh.	SK93	1750
30	G.E.	BC31B	1150
25	Westgh.	SK115	850
25	Westgh.	SK106L	1100

MANY OTHERS—1 HP and Up!

DIESEL-GENERATORS (2)

NEW—31.25 KVA Rogers AC Generators, 3/60/120/208, d/c Exciter, Driven by direct-connected Cummins Diesel Engine, Model H-1—Complete Control Panel—NEW

HI-PRESSURE PUMPS

GPM	MAKE	TYPE	HEAD
800	Worth	6DS	925 ft.
500	Manistee	H	250 ft.
300	Al. Ch.	NM2	800 ft.

SLIP RING MOTORS

3 Phase, 60 cycle, 220 or 440 volts (*2200 Volts or higher)

H.P.	MAKE	TYPE	SPEED
2000	*G.E.	MT30	240
1200	*Cr.-Wh.		240
800	*A.C.	3 Brg	450
650	Westgh.	HE	350
500	Westgh.	CW	350
400	G.E.	IM	450
300	*G.E.	IM	1800
300	G.E.	MT	450
250	*G.E.	MT422	300
200	G.E.	IM	1800
150	G.E.	MT354	1800
150	West. (New)	CS772C	1200
125	G.E. (New)	M6333	900
125	G.E. (New)	M6334	720
100	G.E.	MT543	1800
100	A.C.	ANY	900
100	Westgh.	CW	600
100	G.E.	IM	450
75	A.C.		900
75	Star	OB00	900
75	G.E.	IM-14	600
60	G.E. (New)	M505	1200
60	Westgh.	CW	900
50	G.E.	IM11A	1800
50	A.C.	ARY	1800
50	Westgh.	CW	1200
50	G.E.	MT346	720
50	G.E.	IM	600
50	G.E.	IM14	425
40	G.E.	MT336	1200
40	Westgh.	CW644	900
40	G.E. (New)	M504U	900
35	F-Morse (V)	UAB	1800
35	G.E.	IM	1200
30	G.E.	MT502	900
30	Westgh.	CW445	900
25	G.E.	IM-11	1200
25	A.C.	ARY220	900
25	G.E.	IM	900
20	A.C.	ARY216	1200
20	G.E.	MT312	1200
20	G.E.	MT322	900
20	G.E.	IM	720
20	Westgh.	CW644	600
15	L.All. (New)	OH326	1800
15	G.E.	IM	1200
15	A.C.	ARY216	900
15	Ideal	AVE	900
10	Westgh.	CW324	1800
10	Westgh.	CW365	900
10	G.E. (550 v)	IM (25 cy.)	715

SLIP RING MOTORS

Crane and Hoist Type
M3/60/220 or 440 Volt

H.P.	MAKE	TYPE	SPEED
75	Westgh.	C1756A	600
37	G.E.	HITC (TENV)	600
25	Westgh.	C1572	900
22	G.E.	ITC5000	1200
20	Westgh.	C1	900
15	G.E.	ITC5010-25 cy.	720
11	Westgh.	C1464	900
6½	R & M	425A (TENV)	1200
3	G.E.	MTC5100	1200

TURBINE SPECIAL

312 KVA Crocker-Wheeler AC Generator 3/60/240/480 volt, d/c to.
375 HP Worthington-Moore Turbine, Single Automatic, Non-Condensing, 425 PSI, 10 Nos. Exh., 100° SH with Reduction Gear and Accessories

AC SYNCHRO. GENERATORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2000 volts or higher)

KVA	MAKE	TYPE	P.F.	Spd.
1500	G.E.	ATI	.8	900
1000	*Westgh	803D	.8	900
250	Al-Ch (New)		.8	720
150	El. Machy	EM	.8	720
112.5	*G.E.	ATB	.8	1200
110	Cr-Wh	103	.8	900
100	*G.E.	ATB	.8	900
60	Fr-Morse	8	.8	900
55	G.E.	ATB	.8	1200
50	G.E.	ATB	.8	1200
50	Westgh		.8	1200
50	Cr-Wh	5086	.8	1200
37.5	Al-Ch	EA121	.8	1800

MOTOR-GENERATOR SETS

K.W.	MAKE	A.C.	D.C.
500	Westgh.	2300	250
500	Westgh.	550	250
500	Cr-Wh	220/440	250
450	G.E.	2300	125/250
400	Westgh.	2300	600
250	West.-GE	440	250
200	Cr-Wh	440	250
200	Ridgeway	200	250
150	G.E.	2300/440	250
150	G.E.	440	250/275
150	Cr-Wh	440	250
150	Al-Ch	220	125
100	G.E.	440	250
100	G.E.	220	250
100	G.E.	220	250
75	Al-Ch	440	250
75	Westgh	2300	110
60	Al-Ch	230	110
40	Cr-Wh	220	125
40	EI-P-GE	440	250
40	Al-Ch	440	250
30	Cr.-Wh	220	125
25	G.E.	440	250
20	G.E.	440	250
20	G.E.	440	125
10	Cr-Wh	220	125
10	G.E.	440	250

D.C. TO A.C.

100	G.E.	230	250

BALANCING SETS

34 KW 250 V, 270 A, Neut. Bogus, Type MCI, 123 v. Gen. BB, Compl'd. on Fabricated Steel Base, d/e

20 KW, 230 V, 160 A. Neut. Crocker-Wheeler, Type 151, 125 V, Gen. 3 sl. bearings, close-coupled.

AIR COMPRESSORS

SIZE	MAKE	TYPE	DISPL.	PSI.
10 x10	Ing-R.	ERI	223	120
10 x8	Ing-R.	DRI	179	65
9 x9	Worth.	HB	311	100
9 x8	Ing-R.	ERI	145	100
8½x8	Worth.	HB	170	100
7 x7	Worth.	HB	122	100

AC SYNCHRONOUS MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2200 Volts or Higher)

H.P.	MAKE	Type	P.F.	Speed
800	G.E.	TS984	1.0	1800
750	*Westgh.		.8	900
700	G.E.	TS		514
320	*A.C.	Dr Pf	1.0	720
300	Cr-Wh.	ENG	1.0	300
250	*A.C.	Dr Pf	.8	720
220	G.E.	ATI	1.0	600
200	El. Machy.	Ped	1.0	450
150	El. Machy.	EM	.8	720
150	*Westgh.		1.0	300
125	*El. Machy.	SYN	1.0	900
125	Cr Wh.	1038	1.0	900
125	*G.E.	TS	1.0	277
115	El. Machy.	EM	1.0	240
100	Cr-Wh.	1308	.8	900
100	*G.E.	ATB	.8	900
100	Ideal	SM8	1.0	900
75	G.E.	ATI	1.0	900
60	G.E.	TS7536	1.0	1200
40	G.E.	ATB	.8	1200
20	Fynn-W.	15VRN		1200
15	Century	ARC365	1.0	1200
4	G.E.	AK 25 cy		1500

TRANSFORMERS

3—2000 KVA Pittsburgh, 1 phase 12,000 V Primary 2300 V Secondary

6— 750 KVA Westinghouse—AIR—3 ph., 13,800 V Primary 480 V Secondary

1— 750 KVA Westinghouse—AIR—3 ph., 13,800 V Primary 2300 V Secondary

3— 667 KVA Niagara, 1 phase 13,000 V Primary 480 V Secondary

3— 300 KVA General Electric, 3 ph. 13,800 V Primary 230/480 V Secondary

2— 300 KVA General Electric, 3 ph. 2400 V Primary 240/480 V Secondary

6— 167 KVA General Electric, 1 ph. 2300/4160 V Primary 240/480 V Secondary

First Source for 41 Years for Quality Electrical Equipment

CHICAGO Electric Co.

1320 W. CERMAK ROAD CHICAGO 8, ILL.

UTILITY AND INDUSTRIAL POWER EQUIPMENT

POWER PLANTS

7500KW—600 psi 13.2KV—Oil Fired (50 cycles)

9000KW—180# 600°—2400 volt—Coal or Oil Fired

20,000KW — 250# 550° — 6.6/13.2KV — Oil Fired

TWO—2000KW Turbo Generators—70,000# /HR . . . Boiler—450# 650° Oil Fired

TURBO GENERATORS

25 CYCLE PLANT 25,000KW 200#—1934

CONDENSING—200 PSI: 3500KW—6600 volt —1928 . . . 3500KW—600 volt 1926 . . . 2500KW — 2400 volt — 1924 . . . TWO 10,000KW—1920—425 PSI: THREE 2000KW —480/2400 volt—1943

EXTRACTION—200# ISP: TWO 750KW— —2400 volt—15# Automatic Extraction

NON-CONDENSING — 200# ISP 750KW — 480 volt—10# BP—Rebuilt & Rewound . . . 300KW—rewind—10# BP—1931 . . . Turbine only—2000KW 40# BP—1936

DIRECT CURRENT: 500KW—250 volts—125/ 250# ISP—15# BP—1930

DIESEL

1100KW—480 volt—327 RPM—1941—Complete

UNIFLOW ENGINE GENERATORS

250KW—480 volt—Rewound and Rebuilt . . . TWO 200KW—2400 volt—1927

BOILERS

300,000#/HR—250# 600°—Oil Fired—complete—1934 . . . 35,000#/HR 200#—Stoker—Integral Furnace

TRANSFORMERS

Four—Single Phase—12,500KVA 79/138KV 13.8KV Modern

One—Three Phase—750KVA 13.8KV—240/ 480 Modern

Sixteen—single phase—167KVA 2400—240/ 480 Modern

CONVERTERS—MG's—FURNACES, Etc.

THREE 1000KVA—600 volt Rotaries—1928 . . . 1000KW—250 volt DC 13,200 AC MG SET COMPLETE—1927 . . . 5000KVA FREQUENCY CHANGERS 60 to 25 cycles

ELECTRIC TILTING FURNACE—6 TON—2000KVA Transformers Complete

PAUL STEWART

320 First Nat'l Bank Bldg., Norwood · Elmhurst 1610 · Cincinnati, Ohio

TURBO-GENERATORS

250 KW, 300 KW A.C. and D.C.

2000 KW 3 phase, 50 cycles, 6300 volts

Immediate delivery

Packed in original crates

Complete Specifications and Details Upon Request

INTERNATIONAL FERMONT MACHINERY CO., INC.

115 BROADWAY

NEW YORK 6, N. Y.

BOILERS

1 Erie 400 HP Str. tube 200 lbs. sprdr. stoker

1 Murray Type A 200 lbs.

1 Leffel 40 HP Scotch 100 lbs.

F. W. HAY AND CO.

2734 Cherry St., Kansas City 8, Mo.

BOILERS—COMPRESSORS

1—65,000 lbs. per hr. 450 lbs. pressure sectional steel header, 4" straight tube type boiler.

3—600; 2—565; 2—400 HP B&W vertical forged steel sectional header, 200 lbs. pressure water tube boilers.

Also a number of other boilers up to 1500 HP 600 lbs. pressure.

1—850; 1—1500 cubic ft. motor driven air compressors, 110 lbs.

A full stock of power and distribution transformers, switch gear, including potential and current transformers, circuit breakers etc. at reasonable prices.

We buy entire central station and power stations.

We do our own rigging and dismantling.

HOWE BROTHERS

342 MADISON AVENUE Murray Hill 2-8562 NEW YORK 17, N. Y.

3-667 KVA

General Electric

TRANSFORMERS

1 Phase 60 cycle Type H. Form KD

13.2 K.V. Primary with Four 2.5% Taps, 2300/4000 Y Sec.—newly rewound

J. F. JOYCE

1820 Callowhill St., Phila. 30, Pa.

BOILERS—TURBINES—ENGINES

Boilers 50-2000 HP; Turbo Gen. 100-6000 KW St. Eng. Gen. 75-1000 HP — *Write for our Free New List of High Grade Used Equipment.*

BENJAMIN W. BISSELL, Reg. Engineer
521 K of P Building, Indianapolis 4, Ind.
Phone: Lincoln 4007

TEMPERATURE RECORDERS

27—Used Leeds and Northrup Indicating and Recording Micromax Recorders Model "S" Automatic motor driver self-contained flush mounting.

DALTON SUPPLY CO.

2329 Cedar St. Phila. 34, Pa. GArfield 6-1800

500 & 400 HP 225# CODE WT Boilers
300 & 200 KW Chase Eng. Gen. Sets
1000 KW 600 V. Rotary Converters
21,000 Gal. Permutit Water Softener
600 HP Marine Diesel—full reversing
100 HP NEW 125# CODE HRT Boiler

H. & P., 6719 Etzel, St. Louis 14, Mo.

FOR IMMEDIATE DELIVERY

SUB-PRIOR SALE

1250 K.W. G. E. TURBOGENERATOR

2300 V. 3 Ph. 60 Cy. WITH EXCITER & SPARES

200 PSIG—100° SUPERHEAT—3" BACK PRESSURE

COMPLETE WITH CONDENSER, CIRCULATING, CONDENSATE PUMPS & AIR EJECTOR.

SPECIALTIES SERVICE & ENGINEERING CO., INC.

SEABOARD TRUST BUILDING HOBOKEN, NEW JERSEY

Tel. N. Y. RE. 2-9362 — N. J. HOB. 3-4426

FOR SALE NEW DISTRIBUTION SWITCHBOARD

One dead-front distribution switchboard mounting 1600 Amp. 250 V. Main air circuit breaker and 8—100 Ampere Klampswfuz distribution circuits. 1000 MCM solderless lugs for line side of main circuit breaker. Double right-angle cable trough for use between line circuit breaker and metering board.

Inspection by appointment

NATIONAL STORE FIXTURE CO.

Baltimore 23, Md. Gilmore 6162

POWER EQUIPMENT—READY TO SHIP

A.C. MOTORS
220/440 volt 3 ph. 60 cy.

HP	Make	RPM	Type
250	Gen. Elec.	515	KF576 TEFC
250	Gen. Elec. (Vert.)	1200	2200 V.
250	Gen. Elec.	1200	I-E15A
250(4)	Westinghouse	1775	2300 V.
200	Gen. Elec.		CS 8758
		860	2200 V.
200	Gen. Elec.	450	KF576 TEFC
200(5)	Wagner	1750	RP-3
200	Gen. Elec.	1800	Syn. 2200 V.
175	West.	600	CS945A
175	West.	1200	MS Hi Torq
150	Gen. Elec.	450	TEFC
150	West.	600	Syn.
150(4)	West.	1150	CS8758
150	West.	1200	MS Hi Torq
125	Elec. Mach.	164	Syn.
125(3)	West. NEW	1200	Syn.
100	Fair. Morse	360	Syn.
75	Stanley	600	—
75	Elec. Mach.	900	Syn.
75	Allis Chalmers	1750	2200 V.
75	Louis Allis	1800	FX-5658
60	Gen. Elec.	1800	KT-533
60	Triumph	1200	B-133
50	Crocker Wheeler	900	—
50(3)	West.	900	CS
50(3)	West.	1200	CS
50(2)	Reliance NEW	1780	2200 or 550 V.
50(3)	Gen. Elec. NEW	1750	2200 or 550 V.
40	Gen. Elec.	870	KT-346
40(3)	West.	720	CS
40	Crocker Wheeler	720	—
40(4)	Fair. Morse	1200	H-123B
40	Gen. Elec.	1620	KR-444
40	Allis Chalmers		TEFC Hi Torq
		1750	—
40	Gen. Elec.	3600	FT
35(3)	Onan	1800	Syn.
30	Louis Allis NEW	1800/1200	Frame 445
30	Gen. Elec.	780	KR-444 TEFC
30	Fair. Morse	900	H
30(5)	Allis Chalmers	1750	—
30(2)	Gen. Elec.	3600	KT-205
25	Commonwealth	564	—
25/7.5	Continental	1150/575	A-68X
25/6.2	Continental	1150/570	Linestart
25	Gen. Elec.	1200	KF-405
25	West.	1200	CS-405
25(2)	West.	1800	CS
20	Gen. Elec.	680	KT-532B
20/7½	Gen. Elec.	1165/425	K-504
20	Allis Chalmers	850	—
20	Louis Allis	870	Exp. Proof
20(6)	Allis Chalmers	1150	—
20	Gen. Elec.	1170	2200 V.
20(3)	Gen. Elec.	1760	K-264
15	Gen. Elec.	570	KT-328
15	Gen. Elec.	900	HK
15	West.	850	CS
15	Louis Allis	1750/566	FX-365Y
15	Louis Allis	1150/1740	—
15	Gen. Elec.	3600	KT-952
10	American	1150	TEFC
5(9)	Gen. Elec. NEW	1150	TEFC
5(50)	West.	1150	CS

SLIP RING MOTORS
3 ph.—60 cy.

HP	Make	RPM	Volts
400	Westinghouse	435	2200
350	Westinghouse	320	2200
200	Westinghouse	580	220/440
100	Triumph	580	220/440
75	General Electric	600	220/440
75	General Electric	450	220/440
60	General Electric	570	220/440
60	Burke	1200	220/440
50	General Electric	570	220/440
50	Allis Chalmers	690	220/440
50	General Electric	900	220/440
50	General Electric	1200	220/440
35	Westinghouse	900	220/440
30	Allis Chalmers	575	220/440
25	Westinghouse	570	220/440
25	General Electric	1150	220/440

SPECIAL BARGAINS
Diesel Engine Generator Sets

10—100 kw., 120/240 v. D.C. Delco Generators dir. con. to 150 HP Model GBD-8, 5½x7, 8 cyl. Superior DIESEL Engines, elec. start with engine panels

4—100 KW same as above with 220 or 440 v. NEW A.C. Generators

1—96 kva. Fairbanks Morse 220/440 v. 3 ph. 60 cy. 360 rpm DIESEL

4—25 kva. 120 v. 1 ph. 60 cy. Westinghouse dir. con. to 56 HP., 4 cyl. 900 rpm., LeRoi Gasoline Engines with control panels.

5—25 kw., 220/440 v. 3 ph. 60 cy. Westinghouse direct connected to 4 cyl. LeRoi Gasoline valve in head liquid cooled Engine complete with control panels

3—2½ kw. NEW 115 v. 1 ph. 60 cy. Leland belt driven by Briggs & Stratton air cooled gasoline engines complete with fuel tank and muffler all mounted on steel skids.

NEW EXPLOSION PROOF MOTORS

2—3 HP., 1750/3500 rpm 230 V D.C. Reliance.
3—7½ HP., 1750/3190 rpm 230 V. D.C. Reliance.

CRANES

1 ton Euclid Overhead 29'6½" span, 8' lift, 220/440 v. 3 ph. 60 cy.

1 ton Euclid Overhead 29'10½" span, 8' lift, 220/440 v. 3 ph. 60 cy.

GEARHEAD MOTOR

1—NEW 10 Hp., Westinghouse 220 v. 3 ph. 60 cy. 900 rpm., to 20 rpm type FD-326F, frame WS36 type CS

VARIABLE SPEED MOTORS
230 Volt D.C.

HP	Speed	Make	Type
100	500/1000	Westinghouse	SK-190
100	625/1250	Westinghouse	S-13 L
75	600/1200	Westinghouse	—
50	300/1200	Crocker Wheeler	CMC
40	385/1200	Elec.	—
40	250/1000	Westinghouse	SK-141
25	350/1400	General Electric	RF16A
25	300/1200	General Electric	CD-123
25	325/975	Westinghouse	—
25	500/1500	Westinghouse	SK-110L
20	400/1600	Westinghouse	SK-123
20(3)	500/1500	Westinghouse	SK-110L
15(2)	400/1600	Westinghouse	SK
10(2)	500/2000	Westinghouse	SK-103
10(6)	400/1600	General Electric	—
5(6)	400/1600	Westinghouse	SK-70

MOTOR GENERATOR SETS—
250 V. D.C.
Motors 220/440 volt or 2200 volt

No.	KW	Make	Rpm
2	200	Westinghouse	1200
1	100	Westinghouse	700
1	100	General Electric	900
1	100	Westinghouse	600
1	100	General Electric	1800
1	100	Reliance	580
1	100	Delco	1200

TRANSFORMERS
1 ph. 60 cy.

No.	Kva	Make	Primary	Sec.
3	500	West.	22000	2200
3	200	Pgh.	22000	2300
3	500	Pgh.	4800	120/240
5	200	Allis Chal.	4800	120/240
2	150	Pgh.	4600	115/230
1	110	Pgh.	4600	115/230
6	100	Pgh.	4600	115/230
2	100	Allis Chal.	4800	120/240
3	100	G.E.	4800	120/240
1	75	Pgh.	4600	115/230

ENGINES

NEW 75 HP P.&H. Model 337C 3 cyl. Diesel
Rebuilt 32 HP. Caterpillar Model D-3400 Diesel
NEW 43 HP. International Model U-6 4 cyl.

AUTO TRANSFORMER

3000 kva. output 22000 Y to 2300 v. 3 ph. General Elec.

BAKER LOCOMOTIVE CRANE TRUCK

Model CYA 3000 lbs. at 7' radius with 8 to 12' adjustable telescoping boom complete with slow control, hoist control and boom control.

WRITE, WIRE OR PHONE YOUR ELECTRIC NEEDS—SEND FOR STOCK LIST. LIST YOUR IDLE EQUIPMENT WITH US.

Duquesne Electric & Mfg. Co. Pittsburgh 6, Pa.

FOR SALE

TRANSFORMERS

All 1 phase, 60 cycle, air cooled

No.	KVA	High Voltage	Low Voltage	Mfr.
1	2500	14625/12440	3100/2640	G.E.
2	2000	14100/7510	3100/1493	Whse
3	2000	14000/11990	2940/2785	Whse
6	1000	14000/7510	2945/2795	G.E.
3	1000	14000/7510	2945/2811	Whse
6	50	2750/1375	220/110	Whse
6	25	2750/1375	220/110	Whse

INDUCTION REGULATORS

38—60 KVA induction regulators, 1 phase, 60 cycle, 10% regulation, primary voltage 3000, secondary amperage 200. Westinghouse type C.

CURRENT LIMITING REACTORS

3—115 KVA, 300 amps, 60 cycles, 13200 V
18—91.5 KVA, 300 amps, 60 cycles, 13200 V

OIL CIRCUIT BREAKERS

18—15000 V, 600 amps 8—3000 V, 1200 amps
28— 7500 V, 300 amps 34—3000 V, 300 amps
2— 7500 V, 1200 amps 2—2500 V, 200 amps
1— 7500 V, 600 amps

ALSO: Potential transformers, time element overload and current relays, reverse power relays, auxiliary relays, KWH meters, voltmeters, wattmeters and ammeters.

HUGO NEU CORPORATION

31 Nassau St. New York 5, N. Y.

IN STOCK FOR IMMEDIATE SHIPMENT

NEW and REBUILT MOTORS

3 PHASE, 60 CYCLE, 220 or 440 VOLTS UNLESS OTHERWISE NOTED

HP.	MFG.	RPM	TYPE
1250	G.E.	1800	IM-2300 v*
1000	G.E.	1200	IM-2300 v*
700	West.	300	CW-2300 v**
600†	G.E.	750	IM-2200 v*
250	G.E.	1800	IM-2300 v*
200	G.E.	600	IM-2300 v*
200	G.E.	1200	IM-2200 v*
200	G.E.	600	KT
150	G.E.	514	KT 586
150	G.E.	3600	TEFC
125	West.	180	HR-2200 v**
125	G.E.	450	KT
100†	G.E.	750	IM-2200 v*
75	Ridgeway	720	*
60	Lincoln	900	IXM*
60	G.E.	1780	TEFC
60	West.	1800	445, BB
50	A-C	900	ARCT-TEFC
50	G.E.	900	KG 504 (5)‡
50	G.E.	1200	KG 445 (3)‡
50	G.E.	1200	K 504,TEFC
50	West.	3600	CS 405
40	G.E.	900	KG 445 (2)‡
40	G.E.	900	KT 342
40	A-C	900	TEFC
40	G.E.	1200	KT
40	G.E.	1200	KG,TEFC-XP
40	West.	1800	CS
30	G.E.	1200	KG 405 (4)‡
30	West.	1200	CS 405
30	G.E.	1200	TEFC-XP
30	G.E.	1800	K 365
25	G.E.	1200	FT 532
25	West.	1200	CS 556 C
25	G.E.	1800	FT 503
25	West.	3600	CS 364, Sp
20	West.	1800	CS 364
20	G.E.	720	KT
15	G.E.	900	K 365
15	G.E.	1200	KT 302
15	Baldor	1200	TEFC
15	G.E.	1800	K 326
15	G.E.	3600	KF 334
10	G.E.	900	KG365,TEFC
10	G.E.	1200	XP-Brake
10	L-A	1200	OGA 326‡
7½	G.E.	900	K 326,TEFC
7½	G.E.	1200	KG 3241
7½	G.E.	1800	K 284
5	L-A	900	OGX324(22)‡
5	G.E.	1200	K 284, Splash
5	L-A	1200	OQWE 284
5	Cent.	1800	TEFC-XP
5	G.E.	1800	K 254
5	G.E.	3600	TEFC-XP

* slip-ring ** synchronous † 25 cy. ‡ New

WRITE, WIRE, OR PHONE YOUR REQUIREMENTS
THIS IS A PARTIAL LISTING
WE PAY CASH FOR YOUR SURPLUS

PREFERRED *Electric Motors Inc.*

230 HUDSON AVE., P.O. BOX 767 • ROCHESTER 3, NEW YORK

SLIP RING MOTORS 3-Ph., 60 Cy.

HP	Volts	Make	Speed
500	2200	G.E.	450
450	440/220	Whse.	514
400	2300	G.E.	1200
350	2300/440	G.E.	450
300	440	Whse.	3600
250	440/220	Whse.	600
250	2300/550	G.E.	450
250	550/440	G.E.	1200
200	440	G.E.	600
200	440	G.E.	450
185	4000/2300	G.E.	1800
150	440/220	Whse.	600
150	440/220	Whse. (2)	1800
145	4000/2300	G.E.	1800
125	550/440	G.E.	1200
100	440/220	G.E.	600
100 (2)	440/220	Whse.	900

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

HP	Volts	Make	Type	RPM
400	440/220	G.E.	ATI	600
300	2200/400	G.E.	TS	720
300	440/220	G.E.	ATI	600
250	440/220	Whse.	HR	277
250	440/220	G.E.	ATI	600
250	4000/2300	El. Mchy.	Syn.	600
240	2300/440	G.E.	ATI	720
200	4150/2300	Whse.	G	1800
120	440/220	G.E.	ATI	900
110	440/220	G.E.	TS	257
100	440/220	Whse.	G	1800
75	2300/440	Whse.	GE	600

PLATING UNIT

1—5,000 amp., 4/6 volt (or 2,500 amps., 8/12 volts) A.P. Munning, double commutator, dir. conn. to 50 hp, G.E. sq. cage motor.

CIRCUIT BREAKERS

2—2000 amp., GG E, 3 pole, 600 v., air
2—1600 amp., ITE, 3 pole, 600 v., air
2—1200 ampere, Whse., 3 pole, 600 v., air
1—400 amp., 37500 V., G.E., Type FHKO-236 outdoor type, high interrupting capacity.

SQUIRREL CAGE MOTORS

HP	Volts	Make	Type	Speed
650	440	G.E.	FT	3600
500	2300/4000	Elliot	SC	1800
350	2300	G.E.	KT	1200
300	2300	G.E.	FT	3600
250	440	G.E.	IK	720
200	440	G.E.	IK	514
200	440/220	Whse.	CS	1200
200	440/220	G.E.	KT	1800
200	2200/440	G.E.	KF	720
200	2300/550	Cr. Wh.	SC	900
200	2200/440	G.E.	KT	1200
200	440/220	G.E.	IK	450
150	440/220	Whse.	CS	900
150	440/220	G.E.	IK	450
100	2200/550	Whse.	CS	900
150	440/220	G.E.	KT	720
150	440/220	Howell	B. Brg.	1800
150 vert.	440/220	G.E.	KTF	1200
150	440/220	G.E.	IK	514
150	2300/440	G.E.	KT	600
100	2200/440	G.E.	K	1200
75 (5)	550	G.E.	KF	1800

A. C. GENERATORS

1—320 kva. 600 rpm, 2300/440/220 V., G.E.
1—250 kva. 720 rpm, 2300/440 v., G.E.
1—325 kva. 600 rpm, 220/440 v., G.E.
1—225 kva. 720 rpm, 2300/440 v., G.E.
1—150 kva. 900 rpm, 480/240 v., G.E.
3— 75 kva. 1800 rpm, 480/240 v., Whse.
1— 50 kva. 1200 rpm, 440/220 v., G.E.

D. C. MOTORS

HP	Volts	Make	Type	Speed
350	230 (3)	G.E.	CD	1150
250	230 (2 new)	Cr. Wh.	CMC	1800
150	230 (2)	Whse.	8K	850
150	230	Cr. Wh.	TEFC	900
100	230	Cr. Wh.	CMC	635
100	230	G.E.	CD	1750
75	230	G.E.	CD	1150
75	230	Whse.	8K	850

MOTOR GENERATOR SETS

1—100 kw, 1200 rpm, 240/120 V., Al. Chal., conn. to 150 hp, 440 V., sq. cage.
1—100 kw, 250 v., Hertner, 1200 rpm, connected to 150 hp, 220/440 v., synchronous
1—75/90 kw, 250 V., 1200 rpm, G.E. conn. to 125 hp, 440/220 V., sq. cage
1—75 kw, 125 v., 1200 rpm, G.E. conn. to 120 hp. 2300/440 v., syn. motor.
1—65 kw, 1200 rpm, 250 V., G.E., conn. to 100 hp, 1200 rpm, 440 V., synchronous
1—50 kw, 250/125 V., 1200 rpm, 3-wire, G.E., conn. to 75 hp, 440/220 V., sq. cage

TRANSFORMERS 60 CY.

3—333 kva, G.E., 13,200—2300 V.
2—333 kva, G.E., 4600/2300—220/460 V.
3—300 kva, Whse., 13200—440 V.
3—250 kva, Whse., 11,000/22,000—2300 V.
3—250 kva, Whse., 2300—208 V.
2—200 kva, Whse., 13,200—2300 V. (Inertseen)
4—200 kva, Moloney, 2400—230/460 V.
3—150 kva, Whse., 2400—240/480 V.
3— 75 kva, Moloney, 4150—240 V.
3— 75 kva, G.E., 2400—240/480 V.
6—150 kva, Al. Chal. 2400—240/120 v.
1—150 kva, Whse, SK, 13200-125/215 v., 3 ph.
2— 75 kva, G.E., 480—240/120 v., Pyranol
3— 50 kva, G.E., 480—240/120 V., Pyranol

STEPHEN HALL & CO.

HARRY J. RICE PRES.

458 SEVENTH ST. HOBOKEN, N. J.

MOTOR GENERATOR SPECIAL — *LIKE NEW*

2—500 KW WESTINGHOUSE D.C. GENERATORS, 250 volt, D.C. 2000 amps. 900 rpm Serial No. 8130443-44, Direct Connected to 720 HP Westinghouse Synchronous Motors, 3 phase, 60 cycle, 13,200 volt (Will Reconnect to 2300 volt), 900 rpm Serials 8130447-48. UNITS CAN BE SEEN RUNNING ON PRESENT FOUNDATION IN PHILADELPHIA TILL RELEASE AUGUST 5th, 1951.

OFFERED FOR SALE NOW

$25,000 FOR LOT—AS IS—WHERE IS SUBJECT TO INSPECTION AND PRIOR SALE.

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"Everything from a Pulley to a Powerhouse"

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SPECIAL TRANSFORMERS — YOUR SPECIFICATIONS

NEW TRANSFORMERS OIL COOLED AIR COOLED PHASE CHANGES

ARROW TRANSFORMER CO., INC.

1932 E. Westmoreland St., Philadelphia 34, Pa.

GArfield 5-8433

USED TRANSFORMERS REWOUND REBUILT RECONDITIONED

John H. Benson — Roy L. Wilimzig

MOTORS!!

5—250 HP, 1170 RPM, Allis-Chalmers, Splash-Proof, Frame 630—DSWW, 3/60/2300

1—150 HP, 277 RPM, GE, Synchronous Motor, 3/60/2300, complete with Exciter, Starting Equipment and Magnetic Clutch

1—125 HP, 1800 RPM, F-M, Slipring, Frame R161D 3/60/2300, Control available

1—1000 KVA—AC Generator Westinghouse, 3/60/2300 V. 720 RPM

1—1000 KVA Synchronous Condenser, 3/60/2300/4000 600 RPM

1000 other motors in stock!

Phone, Write or Wire!

BENSON-WILIMZIG, INC.

formerly C & S Machinery Co.

1708 N. 8th St. St. Louis, Mo.

GA-4290

Most all units still on foundation. Many may be seen operating

DIESEL UNITS
240/440/2300 Volts

1000 KVA Elliott-De LaVergne
300 KVA Fairbanks Morse
250 KVA GE-Buckeye
219 KVA (2) Wghse.-Buckeye
200 KVA Fairbanks Morse
187 KVA GE-Buckeye
168 KVA Wghse.-Buda, package type
75 KVA (2) General Motors
50 KVA (2) Fairbanks Morse
225 HP Buckeye (belted)

TURBO GENERATOR UNITS
Condensing—Bleeders

3750 KVA Wghse. 3/60/600 V. (Bleeder)
2500 KVA GE 3/60/600 V. Cond.
1625 KVA Wghse. 3/60/2300 V. (Bleeder)
1250 KVA Wghse. 3/60/2300/4150 V. (450#)
1250 KVA GE 3/60/480/240/600 V. (Bleeder)
937 KVA GE 3/60/600 V. Cond.
750 KVA Al. Chal. 3/60/480/ 240 V.
625 KVA GE 2300/600 V. (Bleeder)
375 KVA Wghse. 3/60/240/480 V. Cond.

TURBO GENERATOR UNITS
Non-condensing

375 KVA (2) Al. Chal. 3/60/240/480 V.
250 KVA GE 3/60/480/240 V. 375# 65-165# hp
156 KVA Al.-Chal. 240/480 V.
125 KVA GE 3/60/240/480 V.
62 KVA GE-DeLaval 240/480 V.

STEAM ENGINE SETS, A.C.
480/240 Volts

625 KVA GE-28x32 Chuse 4 V.
450 KVA GE-Ames Unif. (Cond.)
450 KVA GE-23x28 Chuse 4 V.
312 KVA (2) CW-23x24 Skinner Unif.
219 KVA GE-18x20 Ames Unif.
187 KVA Wghse.-Ames Unif. (Vertical)
125 KVA Wghse.—Ames Unif.
62 KVA GE-13x14 Ames Unif.

BOILERS

30,000# B&W type F; 425#
500 HP Cleaver Brooks 150# (New)
427 HP Bigelow, 3 drum, low hd.
333 HP Bigelow, 3 drum, low hd.
332 HP (2) B&W type H 160#
250 HP (3) Erie City HRT 150#
220 HP (2) Vogt 3 Dr. Low Hd. 160#
200 HP Erie City self contained 160#
150 HP Farrar 2 pass, firebox, 150#
150 HP (3) Murray, low Hd. 250#
150 HP Scotch Marine, 150#
125 HP Keeler Economic, 125#

Above listed units are only a few of our "SPECIALS." Advise your plant requirements.

POWER PLANT EQUIPMENT CO., INC. 39 Cortlandt St. New York, N. Y.

220/440 Volt, 60 cycle SQUIRREL CAGE open, 3 Phase

GUARANTEED REBUILT

QN.	HP	MAKE	TYPE	BEARING	SPEED
1	200	G.E.	IK	S.B.	900
1	200	G.E.	IK	S.B.	720
1	150	G.E.	IK	S.B.	600
1	150	G.E.	IK	S.B.	720
1	150	G.E.	IK	S.B.	1800
2	125	Kling		B.B.*	1800
1	100	West.	MS	S.B.	1200
1	100	West.	CS	S.B.	720
2	100	G.E.	IK	S.B.	720
1	100	G.E.	KT-347	S.B.	1200
2	100	G.E.	IK	S.B.	900
1	100	G.E.	IK	S.B.	1800†
3	100	G.E.	IK	S.B.	1800
1	100	West.	CS-504	S.B.	1800
1	75	G.E.	IK	S.B.	600
2	75	G.E.	IK	S.B.	720
2	75	West.	CS-725C	S.B.	900
1	75	G.E.	K-505	S.B.	1200
1	75	G.E.	IK	S.B.	900†
2	75	G.E.	IK	S.B.	900
4	75	West.	CS	S.B.	1200
4	75	G.E.	IK	S.B.	1200
2	75	F.M.	QS-445	B.B.	1800

QN.	HP	MAKE	TYPE	BEARING	SPEED
2	75	G.E.	IK	S.B.	1200
1	60	G.E.	KT-348	S.B.	900
1	60	G.E.	IK	S.B.	1800
1	60	F.M.	QS-444	B.B.	1800
1	60	G.E.	KT-333	S.B.	1800
4	60	G.E.	IK	S.B.	1800
1	50	G.E.	IK	S.B.	600
3	50	West.	CS	S.B.	900
1	50	G.E.	KT-342	S.B.	900
1	50	G.E.	KT-342	S.B.	900†
2	50	West.	CS-445	S.B.	1200
1	50	G.E.	KT-327	S.B.	1800
2	50	G.E.	IK	S.B.	1800†
3	50	G.E.	IK	S.B.	1800
1	40	G.E.	KT-542	S.B.	720
1	40	F.M.	BH12D	S.B.	900
1	40	G.E.	KT-336	S.B.	900
1	40	West.	CS	S.B.	1200
2	40	G.E.	IK	S.B.	1800†
2	40	G.E.	IK	S.B.	1800
1	35	G.E.	IK	S.B.	720
1	35	Triumph	B12	S.B.	900
3	30	G.E.	KT-312	S.B.	1800

QN.	HP	MAKE	TYPE	BEARING	SPEED
3	30	G.E.	IK	S.B.	1800
5	30	West.	K-365	S.B.*	3600
1	25	G.E.	IK	S.B.	720
1	25	F.M.	B12P	B.B.	720
1	25	Century	SC-30	S.B.	1200
1	25	F.M.	BH12A	S.B.	1200
1	25	Ideal	A 16	S.B.	1200
1	25	West.	CS-471	S.B.	1800
1	20	F.M.	KBV	B.B.	1200
1	20	G.E.	KT-322	S.B.	1200
1	20	G.E.	KT-312	S.B.	1200
1	20	G.E.	K-364	B.B.	1800
1	20	West.	CS-364	S.B.	1800
2	20	G.E.	K-326	S.B.	3600
4	20	Line-Weld	Frame 326	S.B.	3600
2	15	West.	CS	S.B.	720
1	15	Wagner	15 T	S.B.	1200
1	15	Ideal	A	S.B.	1200
1	15	G.E.	KT-502	S.B.	1200
1	15	G.E.	KT-752	S.B.	1800
1	10	G.E.	IK	S.B.	1200
1	10	G.E.	KT-752	S.B.	1200

* Splash proof † 2200 volt

SLIP RING MOTORS

We offer from stock the following 220/440 volt, 60 cycle, 3 phase, GUARANTEED REBUILT equipment, unless otherwise noted.

QUAN.	H.P.	MAKE	TYPE	SPEED	DESCRIPTION
1	15	G.E.	MT 512	900	S.B.
1	30	G.E.	MT 332	900	
1	30	Al. Ch.	ANY	600	
2	40	Al. Ch.	ARY 444	1800	splash proof, B.B.
1	40	G.E.	MT 336	900	S.B.
1	50	G.E.	I-M	900	S.B.
2	60	G.E.	MT 586	600	
1	60	G.E.	MT 346	900	
1	60	G.E.	I-M	900	
1	60	West.	CW 505	1200	
1	75	G.E.	I-M	720	
1	100	G.E.	I-M	720	
1	100	G.E.	I-M	900	
1	125	G.E.	I-M	720	
1	150	G.E.	I-M	600	
1	150	G.E.	I-M	1800	2300 volt
1	200	G.E.	I-M	600	

TOTALLY ENCLOSED MOTORS

FAN COOLED, BALL BEARING, 220/440 volt, 60 cycle, 3 phase, GUARANTEED REBUILT, unless otherwise noted.

QUAN.	H.P.	MAKE	MAKE	SPEED	DESCRIPTION
1	7½	G.E.	KF 284	1800	
1	7½	Reliance	AA 324	1200	XP, NEW
3	10	L.A.	JS 326	1200	
1	15	West.	CS 326	1800	XP, NEW
1	25	L.A.	JS 364	1800	XP, NEW
1	40	G.E.	K 405	1800	
1	50	Master	FB 404	3600	XP, NEW
1	50	Al. Ch.	ARZZ 444	1800	NEW
1	75	G.E.	K 505	1200	

POWER EQUIPMENT COMPANY

8 CAIRN STREET — P. O. BOX 534 — ROHCESTER 2, N. Y.

Telephone: Genesee 5629

FOR SALE

TRANSFORMERS

4—500 KVA, G.E., outdoor type 14.850-16.500 to 230/460 volt, Type A, Form L, OISC.

4—833 KVA G.E. Indoor Type, 14.850-16.500 to 460 volt, Form VDHJ, Type H, OISC.

1—New 100 KVA Core complete, 14.850-16.500 to 460 volt, Westinghouse.

3—75 KVA, G.E. 1,000-9,000 to 2300-460 volt, Form KS, Type H.

3—30 KVA, G.E. 5700/6600 to 110/220/440 OISC. Form G, Type H.

3—15 KVA G.E. 6900-11950Y—115/230, Type H, Form M, OISC.

ROGER PIERCE EQUIPMENT SALES CO.

808 NEWHOUSE BUILDING

SALT LAKE CITY, UTAH

MOTORS - M. G. SETS - COMPRESSORS, ETC.

FAST SHIPMENT

MOTOR GENERATOR SETS 3 Ph. 60 Cy.

KW	MAKE	RPM	D.C. VOLTS	A.C. VOLTS
1250	G.E.	720	275	2200
750	Al.-Ch.	720	250	2300
400	West.	720	550	2300
300	G.E.	1200	275	2300
300	Ridg.	1200	250	2300
300	West.	1200	550	4000/2300
200	Ridg.	900	250	2300
200	West.	1200	275	2300
200	G.E.	1200	275	2300
200	G.E.	1200	250	4000/2300
150	Ridg.	900	250	2300
100	Ridg.	1200	250	2300/440
75	West.	900	75	440/220
35	G.E.	1800	125	440/220

ROTARY CONVERTERS

KW	MAKE	RPM	D.C. VOLTS	A.C. VOLTS
500	G.E. HCC6	1200	250	4000/2300
300	G.E. HC12	600	250	4000/2300
300	West.	1200	250	4000/2300
300	G.E. HCC6	1200	250	4000/2300
150	G.E. HCC6	1200	250	4000/2300

AIR COMPRESSORS

356 CFM, Chg. Pr. 12"x10"—NSB 100 lbs.

500 CFM, 100#, Allis Rotary direct connected 100 H.P. B.B. Motors.

A.C. MOTORS—3 Ph. 60 Cy.

HP	MAKE	RPM	TYPE
1200	G.E.	277	MT—S.R.
600	G.E.	600	MT—S.R.
400	G.E.	450	MT—S.R.
300	G.E.	450	IM—Sl.Rg.
160	G.E.	600	IK-16—Sq. Cg.
150	West.	514	CS954—Sq. Cg.
150	G.E.	600	ATI—Syn.
100 (2)	Allis	720	ARX—Sq. Cg.
100	West.	900	Syn.
100	West.	1200	CS752C—Sq. Cg.
100 (2)	G.E.	450	IM16—Sl.Rg.
75	West.	900	CS—Sq. Cg.
75	G.E.	600	ITC5031A
50	West.	1750	CS
50/12.5	G.E.	900/450	IM 2200 v.
40	G.E.	900	MT—Sl. Rg.
40	West.	900	CS—Sq. Cg.

Also Smaller Units in Stock

TRANSFORMERS—1 Ph. 60 Cy.

KVA	MAKE	PRI.	SEC.
1—3000 (3 Ph)	G.E. Auto	25000	22000
3—500	West.	22000	2200
3—200	Al.-Ch.	22000	2200

Also Smaller Units in Stock

Send us your inquiries for any POWER EQUIPMENT you may require.

MOORHEAD ELECTRICAL MACHINERY COMPANY

361 Noblestown Road Oakdale, Penna. Pittsburgh District

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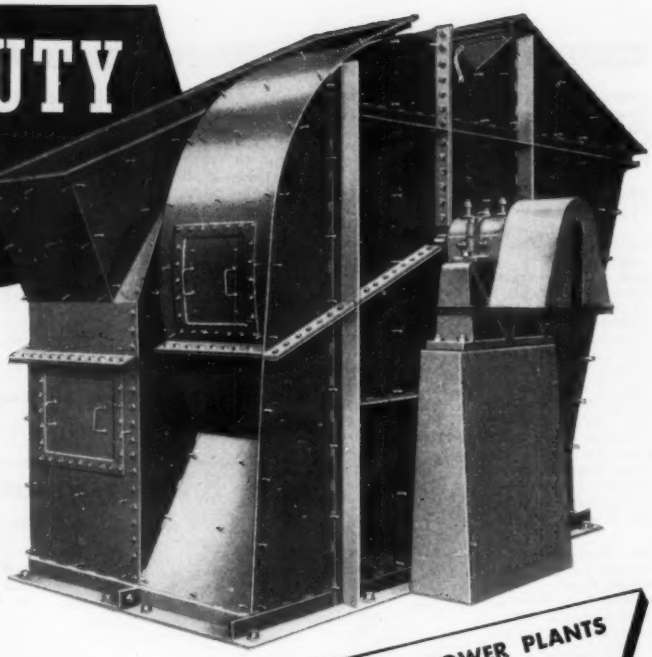
HEAVY-DUTY
for *Important*
FAN JOBS

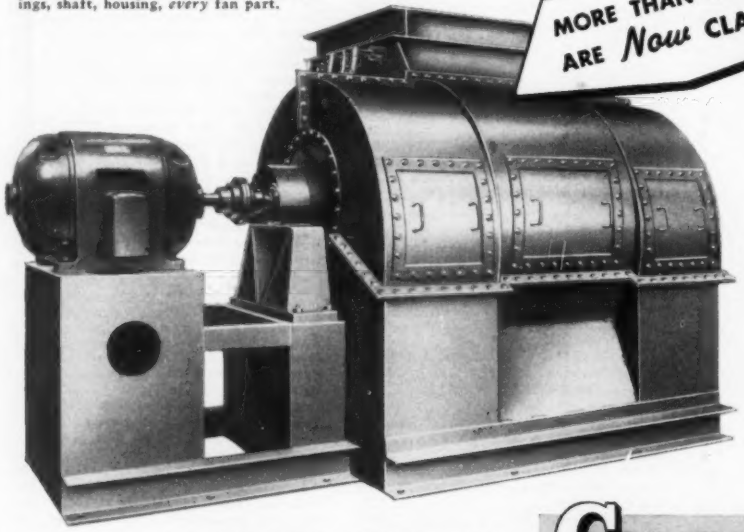


This ad shows Clarage Type RT Fans, especially designed and built for *tough* air handling services — large volumes (up to 300,000 c.f.m.), high static pressures, high temperature applications.

Induced draft is one of the services to which this Clarage equipment is *particularly* adapted. The Type RT Fan at right is arranged for induced draft fan work. It is equipped with inlet box, insulation clips and water-cooled bearings which permit the handling of extremely high temperature gases with long-lasting performance.

Type RT Fan construction is HEAVY-DUTY — and that applies to wheel, bearings, shaft, housing, *every* fan part.

MORE THAN 3000 POWER PLANTS ARE *Now* CLARAGE EQUIPPED



The Type RT Fan at left is equipped with *fan*-cooled bearings. For medium high temperature work (industrial process air handling and some types of induced draft), *fan*-cooled bearings — *a Clarage development* — are practical and *less expensive* than water-cooled bearings.

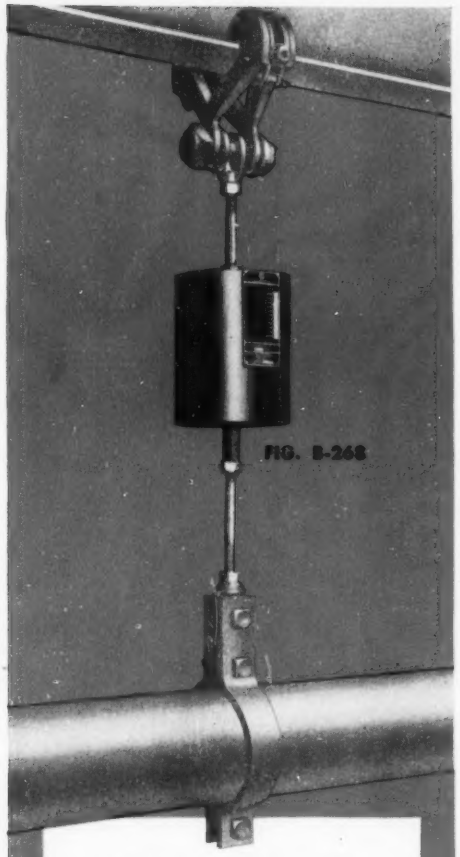
All Type RT Fans operate at speeds suitable for direct drive from electric motors or steam turbines.

DIRECT YOUR INQUIRY INTO CAPABLE HANDS

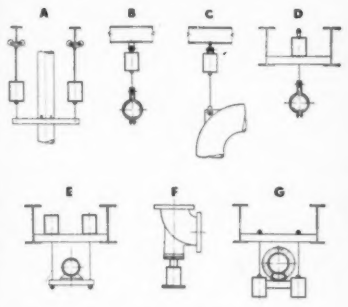
Clarage equipment — from the smallest to largest fans — is built HEAVY-DUTY. Whatever your air-handling problems, we can provide satisfactory results at astonishingly low operating and maintenance costs. *Your inquiry is invited.*

CLARAGE FAN COMPANY
KALAMAZOO, MICHIGAN
Sales Engineering Offices in all principal Cities

CLARAGE
—HEADQUARTERS for Air Handling and Conditioning Equipment



TYPICAL APPLICATIONS



(A) Rod threaded to top cap (B) Furnished with single lug (C) Two lug style (D) Top adjusting (E) Adjustable top and bottom (F) For floor support (G) Trapeze assembly.

Pre-solve Pipe Suspension Problems...

with

Grinnell Pre-engineered Spring Hangers

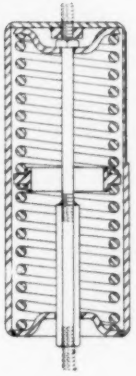
- Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression* assures operation of spring within its proper working range where variation in supporting force is at a minimum.
- Compact—minimum headroom made possible by precompression*.
- Guides prevent contact of coils with casing wall or hanger rod and assure continuous alignment and concentric loading of spring.
- All-steel welded construction meets pressure piping code.
- 16 sizes available from stock — load range from 74 lbs. to 9000 lbs.
- Easy selection of proper sizes from simple capacity table.
- Installation is simplified by integral load scale and travel indicators.
- Unique swivel coupling provides adjustment and eliminates turnbuckle.

**Precompression is a patented feature.*

FOR LESS VARIATION IN SUPPORTING FORCE — FIG. 98

Fig. 98 is an adaptation of Grinnell's popular spring hanger, Fig. 268. It consists of two springs arranged in series within a single casing. A centering guide insures the permanent alignment of the spring assembly.

Fig. 98 has half the load deflection rate, and double the total working range of Fig. 268. Its 16 spring sizes accommodate loads from 74 lbs. to 9000 lbs. — but with a total working range *up to 5 inches!* Fig. 98 comes in the same seven types as shown for Fig. 268. Design details for identical types and sizes are the same for Fig. 98 and Fig. 268.



GRINNELL

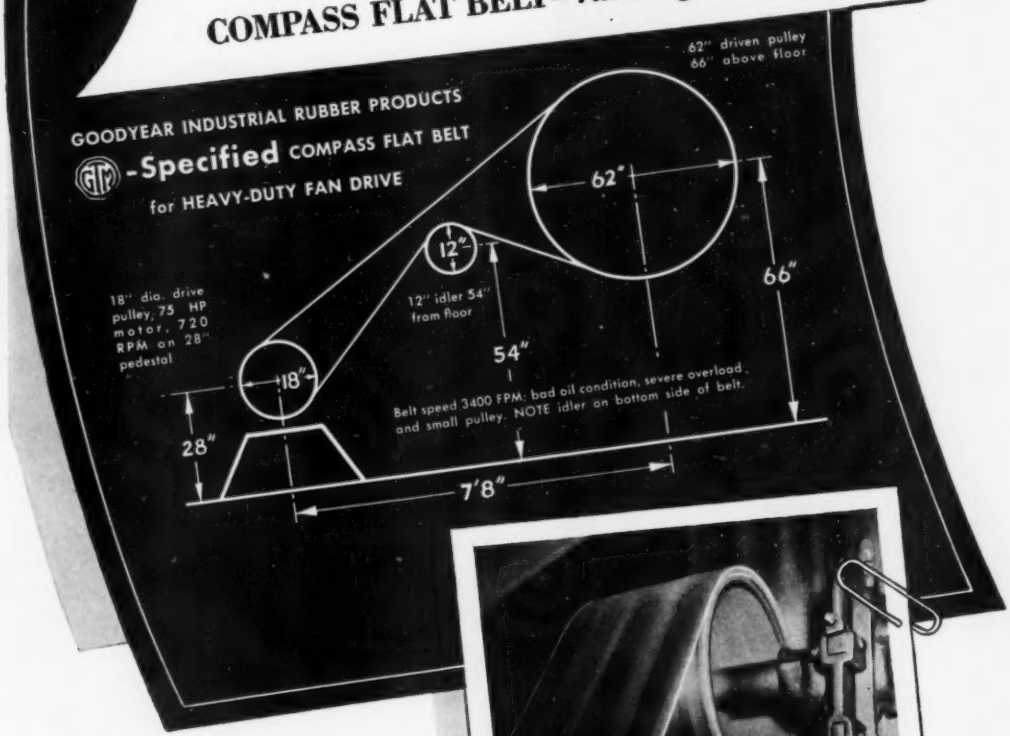
WHENEVER PIPING IS INVOLVED

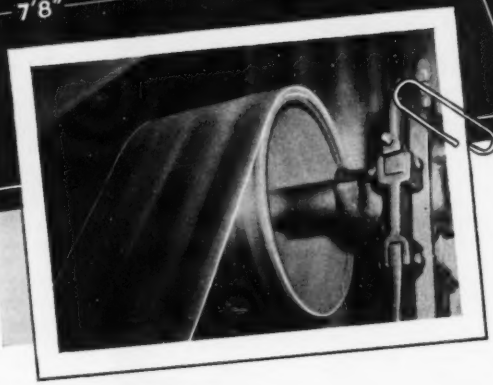
GRINNELL COMPANY, INC., Providence, R. I. Warehouses: Atlanta • Billings • Buffalo • Charlotte • Chicago Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach • Los Angeles • Milwaukee • Minneapolis • New York Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

8 TIMES THE SERVICE

on a tough fan drive

Ordinary belt on heavy drive *lasted 6 months*
G. T. M.–Goodyear Technical Man–specified
COMPASS FLAT BELT–*running 4 years so far!*


GOODYEAR INDUSTRIAL RUBBER PRODUCTS
GTM-Specified COMPASS FLAT BELT
for HEAVY-DUTY FAN DRIVE
62" driven pulley
66" above floor
62"
12"
66"
18" dia. drive pulley, 75 HP motor, 720 RPM on 28" pedestal
12" idler 54" from floor
54"
18"
28"
Belt speed 3400 FPM; bad oil condition, severe overload, and small pulley. NOTE idler on bottom side of belt.
7'8"



FOR HOSE, FLAT BELTS, V-BELTS, MOLDED GOODS, PACKING, TANK LINING, RUBBER-COVERED ROLLS built to the world's highest standard of quality, phone your nearest Goodyear Industrial Rubber Products Distributor, or write Goodyear, Akron 16, Ohio.

GOODYEAR

THE GREATEST NAME IN RUBBER

Compass–T.M. The Goodyear Tire & Rubber Company, Akron, Ohio